# Developing a toolkit to assist in the decision-making process of LSPs to shift to the use of bimodal transport in South Africa

by
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Thesis presented in partial fulfilment of the requirements for the degree of
**Master of Engineering (Engineering Management)**
in the Faculty of Engineering at Stellenbosch University

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December 2021

# Declaration

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# Abstract

South Africa experiences high externality costs associated with transport due to its reliance on the use of trucks for long-distance freight transport. The use of a bimodal system could help to alleviate this. Only a limited amount of visible research has been done on the use of bimodal technology in South Africa. This thesis seeks to contribute to research on the topic by developing a toolkit that allows Logistics Service Providers (LSPs) to conduct investigations into the suitability of the RailRunner bimodal technology for use in their business.

The toolkit was developed by first investigating the road-to-rail industry both locally and internationally, including the RailRunner system and its technology. This information was used to construct selection criteria for potential users of the RailRunner system. Secondly, a preliminary toolkit was set up using the selection criteria and the knowledge gained from the previous investigations. Exploratory interviews were done to flesh out the preliminary toolkit so that a more comprehensive finalised toolkit could be constructed. Validation interviews were then conducted to confirm the usefulness and validity of the finalised toolkit. A toolkit containing the following tools was successfully developed and validated:

- Explanation of the RailRunner system/technology;
- Selection criteria for LSPs that can benefit from the RailRunner system;
- Stakeholder analysis of the role players that may have an interest in or influence on the decision to use the RailRunner system;
- Financial model comparing the operating costs of road-only systems with systems involving the RailRunner technology;
- Decision matrix that assists LSPs in quantifying and visualising their attitudes towards different transport methods;
- Frequently asked questions that help to clear up any misconceptions of the RailRunner system or technology.

The toolkit can now be used by LSPs as a basis for their investigations into the viability of the use of the RailRunner system in their business. RailRunner will also be able to use the toolkit to identify potential customers and to see what the deciding factors are for them choosing to use the system. Preliminary results show that RailRunner would have to make sure that the reliability of their system is equal to or better than that of road transport alone. LSPs must also note that the RailRunner system is not a one-size-fits-all solution. Many factors need to be considered in the decision to use the system. Lastly, this research also provides a basis for numerous potential future research topics related to a road-to-rail shift.

# Opsomming

Suid-Afrika ondervind hoë eksterne kostes as gevolg van die gebruik van vragmotors vir vragvervoer oor lang afstande. Die gebruik van 'n bimodale stelsel kan help om hierdie kostes te verminder. Daar is ook min navorsing gedoen oor die gebruik van bimodale tegnologie in Suid-Afrika. Hierdie tesis ontwikkel dus 'n gereedskapstel waarmee logistieke diensverskaffers ondersoeke kan doen op die geskiktheid van die RailRunner bimodale tegnologie vir gebruik in hul besigheid.

Die gereedskapstel is ontwikkel deur eers die pad-tot-spoor industrie in Suid-Afrika en in die buiteland, en die RailRunner stelsel en tegnologie te ondersoek. Hierdie inligting is daarna gebruik om seleksiekriteria op te stel vir potensiële gebruikers van die RailRunner stelsel. Tweedens is 'n voorlopige gereedskapstel opgestel met hulp van die seleksiekriteria en die kennis wat uit die voorheen genoemde ondersoeke opgedoen is. Verkennende onderhoude is gedoen om by te las by die voorlopige gereedskapstel sodat 'n meer omvattende afgehandelde gereedskapstel opgestel kan word. Validasie onderhoude is daarna gevoer om die nut en geldigheid van die afgehandelde gereedskapstel te bevestig. 'n Gereedskapstel wat die volgende gereedskap bevat, was suksesvol ontwikkel en gevalideer:

- 'n Gedeelte wat die RailRunner stelsel/tegnologie verduidelik;
- Keuringskriteria vir logistieke diensverskaffers wat kan baat deur die RailRunner stelsel te gebruik;
- Ontleding van belanghebbendes oor die rolspelers wat 'n belang of invloed kan hê op die besluit om die RailRunner stelsel te gebruik;
- 'n Finansiële model wat die bedryfskoste van pad stelsels vergelyk met stelsels wat die RailRunner tegnologie insluit;
- 'n Besluitmatriks wat logistieke diensverskaffers help om hul houding teenoor verskillende vervoermetodes te kwantifiseer en te visualiseer;
- 'n Gedeelte oor algemene vrae wat help om enige wanopvattings van die RailRunner stelsel of tegnologie op te klaar.

Die gereedskapstel kan nou deur logistieke diensverskaffers gebruik word as 'n basis vir hul ondersoeke op die lewensvatbaarheid van die gebruik van die RailRunner stelsel in hul besigheid. RailRunner sal dit ook kan gebruik om potensiële kliënte te identifiseer en om te sien wat die beslissende faktore vir potensiële kliënte is. Voorlopige resultate toon dat RailRunner moet seker maak dat die betroubaarheid van die RailRunner stelsel gelyk is aan of beter as die van die pad. Logistieke diensverskaffers moet ook daarop let dat die RailRunner stelsel nie 'n oplossing vir almal is nie. By die besluit om die stelsel te gebruik, moet baie faktore in ag geneem word, soos

aangedui in die gereedskapstel. Laastens bied hierdie navorsing ook 'n basis vir talle moontlike toekomstige navorsingsonderwerpe wat verband hou met onder meer 'n pad na spoorverskuiwing en die vermindering van uitlaatgasse.

# Acknowledgements

I would like to thank the following people who have helped me to undertake this research:

The Royal Academy of Engineering for providing the much-needed funding for this project.

My supervisor Dr Joubert van Eeden and co-supervisor Mr Zane Simpson for their support. They always went the extra mile when providing feedback and were quick to respond with advice whenever I needed it. I could not have asked for better supervisors.

The experts that took the time out of their day to share their knowledge with me.

My parents for supporting me both financially and emotionally. They have truly opened more doors for me than I could ever have dreamt of. I would not be who I am today without their wisdom and input in my life.

My fellow student, Mr Martin du Plessis. His sense of humour and love for life helped me get through times where workloads were high.

Almighty God, for placing these people in my life and providing me with the opportunities that I have had in my life.

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# Glossary

**Bimodal Technology** Technology that can be used interchangeably in two modes of transport.

**Bimodal Transport** Transport that makes use of Bimodal technology. In the case of this thesis, this refers to transport involving road and rail.

**Capecor** The transportation corridor between Gauteng and Cape Town.

**Framework** A conceptual framework is a network, or "a plane", of interlinked concepts that together provide a comprehensive understanding of a phenomenon or phenomena. The concepts that constitute a conceptual framework support one another, articulate their respective phenomena, and establish a framework-specific philosophy (Jabareen, 2009).

**Gauge** "The gauge of a railway track is defined as the clear minimum perpendicular distance between the inner faces of the two rails." (*railsystem.net* 2021)

**Intermodal transport** Transport that involves the use of more than one mode, such as road, rail, sea or air.

**Natcor** The transportation corridor between Gauteng and Durban.

**Roadrailer** "A vehicle, especially a goods vehicle, that can run on both road and rail" (*Oxford Dictionary* 2020).

**Tare weight** The combined weight of a vehicle and trailer before it is loaded with freight (LaGore, 2021).

**Twenty-foot Equivalent Unit (TEU)** A unit of measurement used to represent a twenty-foot shipping container. One forty-foot container is equivalent to two twenty-foot containers or two TEU (*TEU* 2021).

**Toolkit** "A set of tools designed to be used together or for a particular purpose. A fixed set of procedures, guidelines, criteria, etc, established to ensure a desired or required result or prevent oversights" (*Toolkit definition and meaning — Collins English Dictionary* 2021).

# Acronyms

**COFC** Containers on flatcars

**CPK** Cost Per Kilometre

**DC** Distribution Centre

**FMCG** Fast-moving Consumer Goods

**GDP** Gross Domestic Product

**GHG** Green House Gas

**LSP** Logistics Service Provider

**RO-RO** Roll On Roll Off

**SLR** Systematic Literature Review

**SWOT** Strengths Weaknesses Opportunities and Threats

**TEU** Twenty-foot Equivalent Unit

**TOFC** Trailers on flatcars

# CHAPTER 1

# Introduction

Contents



## 1.1 Background

Global warming is one of the greatest challenges that the modern world must face. To be sustainable, the amount of Green House Gas (GHG) emissions will have to be decreased. In 2010 road transportation was responsible for 72% of GHG emissions in the global transport sector while rail was responsible for only 1.6% (Intergovernmental Panel on Climate Change, 2014). In 2016 the South African Minister of Environmental Affairs, Mrs Edna Molewa, signed the Paris Agreement on Climate Change. The agreement is a framework that guides international efforts to limit GHG emissions. It also increased the urgency of low carbon development from 2020 onwards (Intergovernmental Panel on Climate Change, 2014).

In 2014 South Africa's logistics costs were 11.2% of the country's Gross Domestic Product (GDP). This amounted to R429 billion. Road transport contributed 83% to transport costs in 2014 while rail tariffs contributed 15% (Havenga, Z. P. Simpson, King, D. de Bod, et al., 2016). This shows that road transport is clearly the highest contributor to logistics costs. Furthermore, South Africa spent a large amount of money on its roads (1.2% — 1.6% of its GDP) compared to other developed countries (0.1% — 1.4% of their GDP) in 2010 to 2014 (van Rensburg and Krygsman, 2019). "South Africa's logistics costs are higher than the global average" (Havenga, 2010). An effective way to lower these costs would be to shift road freight transport to rail (Havenga, Z. P. Simpson, Fourie, et al., 2011).

There are many externality costs when it comes to the transport of freight on roads. These costs include GHG emissions, accidents, congestion, policing, road maintenance and noise pollution. Road transport is affected more severely by externality costs than rail is. This contributes to the fact that rail is much cheaper over long distances than road transport (Havenga, Z. P. Simpson, Fourie, et al., 2011).

Long-distance transport in South Africa is dominated by road transport (Van Eeden and Havenga, 2010). However, long-distance transport of freight is much better suited for rail. Ideally, trucks would do the collection and distribution of freight and rail would be used for the high-density, long-distance transport segment (Van Eeden and Havenga, 2010). Intermodal transport is transport that involves the use of more than one mode, such as road, rail or air. Bimodal transport is a subset of intermodal transport that makes use of only two modes. The two modes that this thesis focuses on are road and rail transport.

The above information considered, it would be highly advantageous for South Africa to develop road-to-rail bimodal solutions. RailRunner is a company that has found success in the bimodal transportation market in North America. They implement bimodal technology (roadrailer concept) that makes use of compact specialised rail vehicles called bogies which connect specialised truck trailers to assemble a train that can be hauled by a locomotive as seen in Figure 1.1 and 1.2. The truck wheels are raised by the bogie to clear the track, thus transforming the road trailer into a rail wagon as seen in Figure 1.3. RailRunner is one of the few companies that has been able to successfully provide a technology solution to enable fast and effective road-to-rail bimodal freight distribution. RailRunner has now started working on implementing their solution on the narrower Cape gauge used in South Africa (which has not seen a widely successful implementation of a road-to-rail solution in recent years (Havenga, Z. P. Simpson, and de Bod, 2012a) (Havenga, Z. P. Simpson, Fourie, et al., 2011)). RailRunner is now at a stage where they need to identify users that would benefit from using their bimodal technology in South Africa.

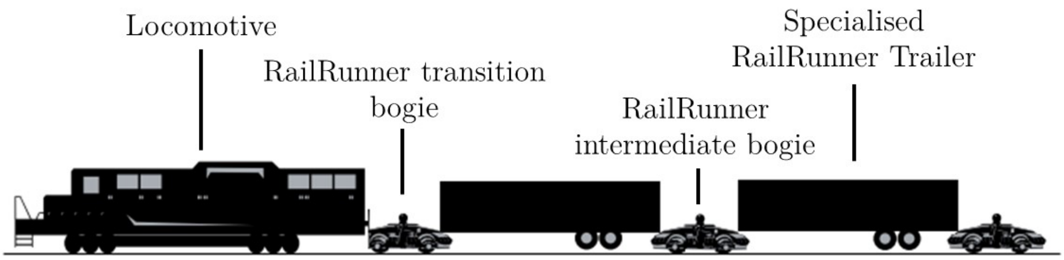


FIGURE 1.1: *RailRunner assembly (RailRunner, n.d.[a])*

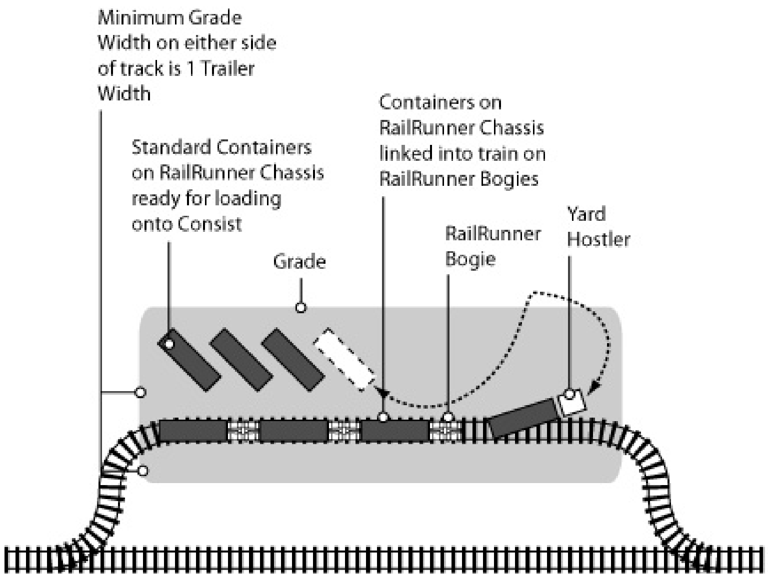


FIGURE 1.2: *RailRunner assembly infrastructure (RailRunner, n.d.[b])*

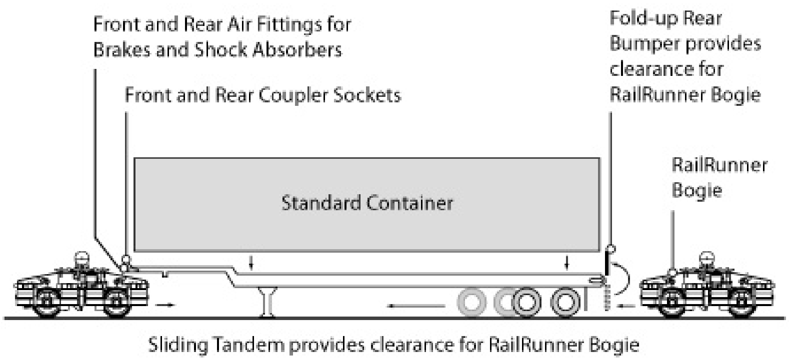


FIGURE 1.3: *RailRunner trailer and bogie system (RailRunner, n.d.[b])*

## 1.2 Problem statement

Little research has been done on the implementation of a roadrailer bimodal freight transport concept in South Africa. One of the most important aspects to consider is whether companies are willing and able to use the technology. There are two types of companies that need to be considered, namely Logistics Service Providers and freight owners. These two types of companies must be willing to commit to the RailRunner system. The Logistics Service Provider (LSP)s would have the greatest influence in the decision to use this technology, therefore the main focus of this investigation will be on them. The freight owners are, however, considered as important stakeholders.

A toolkit needs to be developed to allow LSPs to conduct their own investigations into the suitability of the technology for use in their business. The toolkit must provide the crucial tools and information necessary to be able to make an informed decision. The toolkit must include a financial model, stakeholder analysis, decision matrices and any other tools identified by this research.

## 1.3 Rationale for the study

This project provides a useful tool for RailRunner South Africa to be able to move their business forward. At the time of writing this thesis, RailRunner South Africa is at a stage where they require capital in the form of investments so that they can manufacture a few initial bogies and trailers. This equipment will be used to run a trial on the Cape Town to Gauteng transport corridor (known as the Capecor) to demonstrate the process and show that it works reliably. To acquire the capital, RailRunner South Africa must be able to show that their business is worth investing in. The most important problem they face is being able to show that they can acquire users that are willing and able to use the RailRunner system. Therefore, it is important to develop a toolkit that enables LSPs to assess the feasibility of the RailRunner technology for use in their business.

Another aspect to consider is that of the environment. By empowering RailRunner South Africa and LSPs, a large volume of goods could be transported by rail instead of on road with trucks. This significantly reduces GHG emissions and reduces the consumption of fuel.

The economy could also potentially benefit greatly. RailRunner South Africa states that they would be able to create many job opportunities in South Africa centred around the manufacturing of RailRunner equipment and management of the RailRunner system. The maintenance cost of South African highways and road congestion could also decrease significantly. Furthermore, less fuel would have to be imported which means that less money would leave South Africa.

Since South Africa has not seen a widely successful implementation of bimodal transport and limited research has been done on the subject, this research provides a useful stepping stone for future research in bimodal transport in South Africa. The outcome of this thesis not only provides RailRunner with the necessary tools to make an informed decision on the use of bimodal transport, but also any individuals or companies interested in using road and rail bimodal technology.

## 1.4 Objectives

### 1.4.1 Objective 1: Literature review

Information from various sources such as Google Scholar, ScienceDirect and Web of Science were used to do the literature study. These sources are in the form of academic papers, books and articles. The goal is to gain a clear understanding of the following topics:

- Bimodal transportation in other countries;
- The road and rail industries in South Africa;
- Characteristics of rail transport;
- Characteristics of road transport;
- Commodity types suitable for bimodal transportation;
- The advantages of moving transport from road-only to bimodal transport;
- The challenges of moving from road-only to bimodal transport;

- The transport criteria/requirements of LSPs and freight owners.

Some of these topics require in-depth, and definitive answers to be able to set up selection criteria and a preliminary toolkit. That is why the literature review will have two parts. The first part (thematic literature review) will provide a background to the inland transport industry of South Africa. The second part (structured literature review) will provide definitive answers to the key questions that were identified in the first part (thematic literature review). The input, process and output of this objective can be seen in Figure 1.4.

| Input | Process | Output |
|---|---|---|
| • Information from various sources such as Google scholar, ScienceDirect, Web of Science etc. | • Sorting, reading, interpreting different sources to find commonalities among certain topics. | • Systematic literature review. |

FIGURE 1.4: *Objective 1 input, process, output*

### 1.4.2 Objective 2: Defining selection criteria for potential users

After the literature study was completed, preliminary selection criteria for potential users were set up. The increased knowledge of topics such as commodity types and transport criteria assist in assigning greater importance to certain criteria. The characteristics of the RailRunner system must also be considered when selecting the criteria. Therefore, a chapter has been included after the literature study to explore the RailRunner system and technology. The input, process and output of this objective can be seen in Figure 1.5.

| Input | Process | Output |
|---|---|---|
| • Literature review<br>• Section on RailRunner system and technology. | • Combination of the two inputs to create a list of criteria that an LSP would have to adhere to, to be suitable for implementation of the RailRunner system. | • Selection criteria for potential users. |

FIGURE 1.5: *Objective 2 input, process, output*

### 1.4.3 Objective 3: Preliminary toolkit

After the knowledge has been gained from conducting the literature review, discussing the RailRunner system, and the selection criteria have been defined, a preliminary toolkit is constructed. This toolkit is used to conduct the exploratory interviews so that the toolkit can be fleshed out. The input, process and output of this objective can be seen in Figure 1.6.

| Input | Process | Output |
|---|---|---|
| • Literature review.<br>• Section on RailRunner system and technology.<br>• Selection criteria for potential users. | • Using the combined knowledge of the inputs to construct a preliminary toolkit. | • Preliminary toolkit. |

FIGURE 1.6: *Objective 3 input, process, output*

### 1.4.4 Objective 4: Finalised toolkit

Semi-structured exploratory interviews were done to add to and refine the preliminary toolkit. These interviews built on each other and were therefore not meant to function as validation for the toolkit. The interviews provided an effective way to identify key factors that might not be evident at first. Once the toolkit (now labelled as the finalised toolkit) had reached a satisfactory level of completion, then validation interviews began. The input, process and output of this objective can be seen in Figure 1.7.

| Input | Process | Output |
|---|---|---|
| • Preliminary toolkit.<br>• Knowledge gained form previous exploratory interviews done. | • Conducting exploratory interviews that build on each other and the finalised toolkit. | • Finalised toolkit. |

FIGURE 1.7: *Objective 4 input, process, output*

### 1.4.5 Objective 5: Validation of the finalised toolkit

Validation interviews were conducted to validate the finalised toolkit. These interviews involved talking with various subject matter experts about the validity and usefulness of the toolkit. The information gained from these interviews was collated and summarised. The input, process and output of this objective can be seen in Figure 1.8.

| Input | Process | Output |
|---|---|---|
| • Finalised toolkit. | • Conducting validation interviews and case studies.<br>• Writing up results and suggestions. | • A comprehensive answer on the validity and usefulness of the toolkit. |

FIGURE 1.8: *Objective 5 input, process, output*

## 1.5 Project scope

In the process of shifting from road-only to road-and-rail-bimodal transport there is a wide range of aspects to consider. These aspects include:

- Origin and destination of the freight;
- Distance of the transport;
- Transport volumes;
- The size of the company involved;
- Unique aspects of the LSP and freight owner;
- Type of freight transported (commodities);
- Perspective of all the stakeholders involved.

As seen in Figure 1.9 the Cape Town to Gauteng transport corridor (Capecor) has one of the highest tonne-km values as well as one of the highest average total distances (Van Eeden and Havenga, 2010).

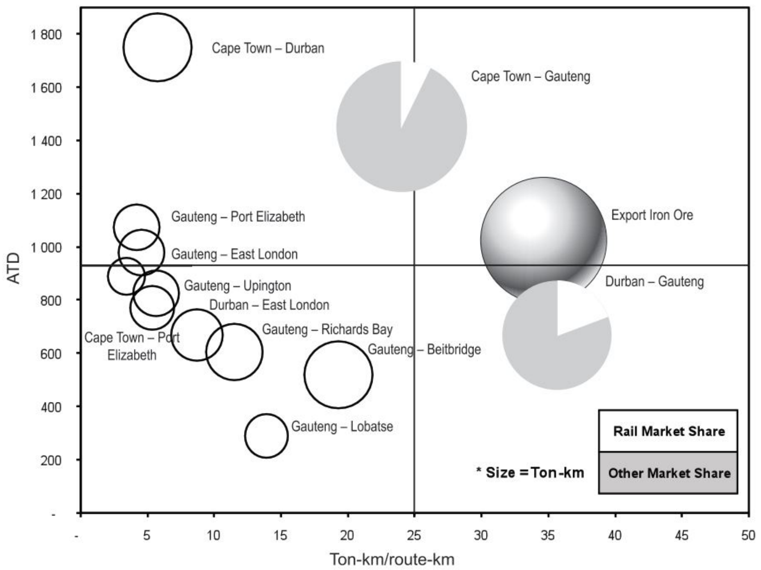


FIGURE 1.9: *Average travel distance vs tonne-km (Van Eeden and Havenga, 2010).*

Since bimodal transport involving rail transport is better suited to freight transport involving long distances and high volumes, the focus of this thesis is on the Capecor. The toolkit will also be useful for the Durban-Gauteng corridor (known as the Natcor) and other high-volume and long-distance transport corridors. Distribution Centre (DC)-to-DC transport will also be focused on since it involves long-distance and high-density transport. An illustration of this can be seen in Figure 1.10.

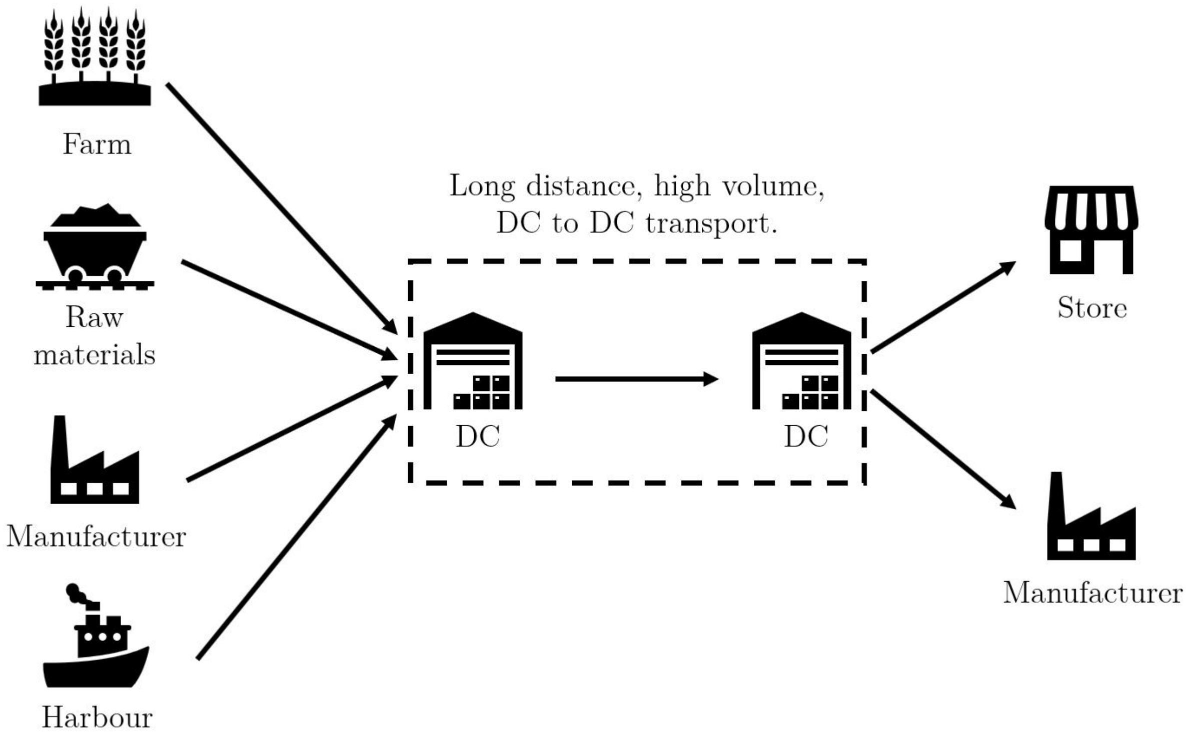


FIGURE 1.10: *DC-to-DC transport*

It should be noted that the transport volumes of the transport corridors are taken into account but not the transport volumes of the LSP or freight owners. This means that big companies with large volumes as well as small companies with small volumes are considered for this research. This is because RailRunner will not discriminate between companies in terms of freight volumes.

It is difficult to create a toolkit that incorporates all the unique tools that every LSP in South Africa may need. The toolkit therefore only focuses on critical decision-making tools that any LSP would require to conduct their investigation.

Certain commodities are better suited for bimodal transport than others. A greater focus is put on those commodities and they are discussed in Section 5.3.

Even though there are many forms of bimodal technology used globally, this thesis will focus on the technology that RailRunner South Africa provides. This is because they are currently the only company that is working on transforming the road-to-rail industry in South Africa. There is also a lack of research on this type of bimodal technology, especially in South Africa. This research will be useful in the use of other roadrailer systems and is not limited to the application to the RailRunner system.

Lastly, the stakeholders that have the greatest influence in the decision on moving from road-only to bimodal transport would be the LSPs. Therefore, the toolkit was designed to be used from the perspective of the LSPs. Freight owners are, however, also considered as important stakeholders.

## 1.6 Methodology

As seen in Figure 1.11 the introduction establishes the objectives and methodology. The literature review was undertaken with these objectives in mind. The selection criteria were set up with the use of the information gained from the literature review and a section was included on the RailRunner system and technology. The literature review, the section on the RailRunner system and technology, and the selection criteria were all used to set up a preliminary toolkit. This preliminary toolkit was used as an input to construct a structure for exploratory interviews. Each exploratory interview builds upon the next exploratory interview as well as adding to the finalised toolkit. The finalised toolkit was then used to conduct validation interviews. Lastly, conclusions and recommendations were discussed while keeping the entire process in mind.

Figure 1.11 demonstrates this process by showing the flow of one chapter to another. The arrows point from inputs to outputs. Rectangles with dark outlines encase multiple chapters to show that multiple inputs were used for the next chapter. A decision was made to place the preliminary toolkit in Appendix B while the finalised toolkit is included in the main body of the thesis. This was done to avoid the redundant process of explaining some aspects of the toolkit twice.

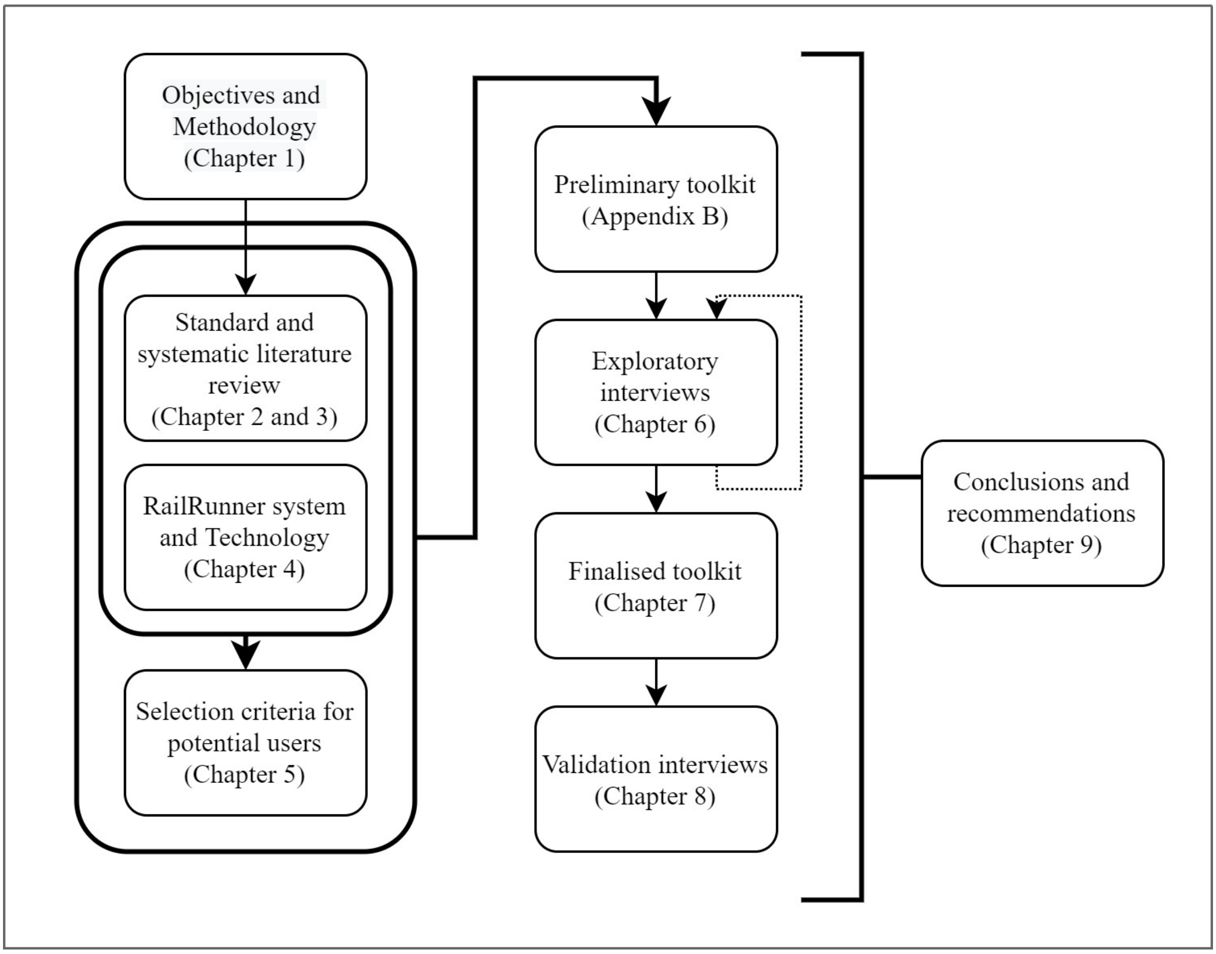


FIGURE 1.11: *Methodology flow chart*

A snowballing sampling technique was used to acquire participants for exploratory and validation interviews. Snowball sampling is a method of sampling whereby participants provide referrals for identifying further potential participants. This is especially useful when there is no readily available list of participants or if the participants are hard to find. It is also useful for collecting qualitative and quantitative data (*Snowball Sampling: Definition, Method, Advantages and Disadvantages — QuestionPro* 2021). This technique was chosen for this thesis since there is no set database of participants that have the needed expertise that is needed for the interviews. A few potential participants were identified. The participants chosen to participate were able to identify the shortcomings in their knowledge and provide referrals to other participants that would be able to fill in the gaps in their own knowledge. One disadvantage of this method is that participants may have a similar outlook as the participant that referred them. To combat this as many primary participants (participants contacted without a referral) were contacted from different sectors of the transport industry. This sampling technique can provide a complete and thorough understanding of the industry and is the best way of validating the toolkit.

Even though this thesis makes use of both qualitative and quantitative research approaches, it leans more toward qualitative methods. It focuses mostly on the participants' viewpoint and seeks to obtain rich, deep, thick data rather than the hard, reliable data that quantitative research is known for (Bryman et al., 2014). The implementation of a roadrailer bimodal concept in South Africa has yet to take place, and it is a new field of research. It is therefore advantageous to make an exploratory and flexible investigation to obtain a general overview instead of doing an in-depth investigation into a singular part of the industry. The exploratory interviews allowed for topics to be addressed that were not initially thought necessary to be included in the toolkit. This way the toolkit could grow to include aspects that the literature review or selection criteria were not able to identify.

This thesis sets out to develop a toolkit. One alternative to a toolkit is that of a roadmap, which is a plan or strategy intended to achieve a particular goal (Petrick, n.d.). The reason a toolkit was chosen over a roadmap is because every company or individual has alternative methods of conducting investigations based on what they find important and how they would order the different elements of their investigation. There is no one-size-fits-all solution when it comes to a complex problem such as a shift from road to rail. This causes the scope of factors that one needs to consider, to grow to an unmanageable size. A set of crucial tools, or a toolkit, would allow a potential user of bimodal transport to set up their own roadmap according to their individual needs and preferences.

Another alternative to a toolkit is that of a framework. A framework is a network of interlinked concepts that provides a comprehensive understanding of a phenomenon or phenomena (Jabareen, 2009). The implementation of a roadrailer concept in South Africa is a new development. It would, therefore, be difficult, if not impossible, to set up a framework since the phenomenon of the implementation of a roadrailer system has yet to take place.

## 1.7 Ethical implications of the study

When doing interviews, data from the companies involved may be used. This data could be confidential, and it may impact the companies negatively if the data were to be shared openly. Care must be taken to protect the data that is used in the study. No company names or names of individuals are used in this study.

Ethical clearance was received for data collection from the Research Ethics Committee of Stellenbosch University for Social, Behavioural and Education Research. It must also be mentioned that no persons under the age of eighteen were interviewed for this study.

# CHAPTER 2

# Literature review on the use of road-to-rail bimodal freight transport in South Africa

Contents



## 2.1 Introduction

Intermodal transport is transport that involves the use of more than one mode, such as road, rail, sea or air. Bimodal technology is technology that can be used interchangeably in two modes of transport. Bimodal transport is transport that makes use of this technology. The two modes that this review focuses on, are road and rail transport.

The aim of this thesis is to develop a toolkit that allows LSPs in South Africa to determine the viability of using bimodal technology in their business. Although freight owners are seen as important stakeholders, the toolkit is developed to be used primarily by logistics service providers

(LSPs). Furthermore, the toolkit is developed for the Cape Town-to-Gauteng transport corridor (Capecor), but it will also be useful to use on other transport corridors such as the KwaZulu Natal-to-Gauteng corridor (Natcor). Not only LSPs but also bimodal operators, such as RailRunner, must be able to use the toolkit to conduct their own investigations to identify potential users of bimodal technology.

A wide variety of subjects needs to be addressed when considering the use of bimodal transport in South Africa. These include commodity types, different bimodal technologies and transport criteria. Therefore, this literature review explores the following topics:

- Different types of bimodal systems/technology.
- Deregulation of freight transport in South Africa.
- Logistics costs in South Africa.
- Externalities of freight transport in South Africa.
- Freight flows in South Africa.
- Percentage of rail-friendly freight in South Africa.
- The case for use of bimodal transport in South Africa.
- Choice of mode of transport in South Africa.
- Criteria for viable bimodal transport in South Africa.
- Commodities best suited for bimodal transport in South Africa.

An understanding of these topics makes it possible to set up selection criteria for LSPs that can benefit from using bimodal technology. It also aids in establishing a preliminary toolkit.

Even though there are many types of road-to-rail bimodal solutions and technologies, this thesis focuses on the RailRunner system and technology. This is because of the progress that they have made in South Africa, and the lack of other competing solutions. However, to first establish a broad view of the industry as a whole, this literature review focuses on all forms of road-to-rail bimodal solutions in general. Chapter 4 explores the RailRunner company and their solution in detail. All the chapters following Chapter 4 are written with the focus on the RailRunner system.

## 2.2 Different types of bimodal systems/technology

In order to understand road-to-rail bimodal transport, one must first understand the different solutions that can be used. These solutions fall under three main categories, namely; containers on flatcars (COFC), trailers on flatcars (TOFC), and roadrailers. The following three subsections explore these solutions.

### 2.2.1 Containers on flatcars (COFC)

Containers on flatcars or COFC, involve the moving of shipping containers from truck trailers to railcars and vice versa. This involves large gantry cranes as seen in Figure 2.1 or smaller cranes as seen in Figure 2.2.


FIGURE 2.1: *Gantry crane lifting a container from a railcar (Mykola, 2021)*


FIGURE 2.2: *Crane moving a container from a truck trailer to a railcar (Tarragona Port, 2021)*

This method requires terminals with large cranes, expensive equipment, and railcars and truck trailers that are both capable of transporting containers (Johnston and Marshall, 1993). This method is therefore seen as less flexible than other solutions.

### 2.2.2 Trailers on flatcars (TOFC)

Trailers on flatcars or TOFC, involves the moving of truck trailers onto railcars and vice versa. This can be done using a crane loading or drive-on loading.

### Crane loading

Figure 2.3 shows how cranes can be used to load truck trailers onto flatcars. This method of transport results in a high centre of gravity and additional forces experienced by the freight resulting in damage (Johnston and Marshall, 1993). This method does not offer a significant improvement in flexibility compared to COFC.


FIGURE 2.3: *Truck trailer lifted onto a railcar by crane (Averitt Intermodal, 2021)*

### Drive-on loading

Figure 2.4 shows how trucks and their trailers can be driven onto specialised railcars. These specialised railcars lower the high centre of gravity seen with use of trailers on conventional railcars. This method is the most flexible way of shifting freight from road to rail due to the small number of movements that must be made in the loading process. One drawback is that the extra weight of transporting the truck along with the trailer limits the weight of the freight that can be carried.

Figure 2.4: *Trucks on railcars (Bulk Distributor, 2021)*

### 2.2.3 Roadrailers

Roadrailers involve using a combination of specialised truck trailers and rail bogies that connect to form a train. This system allows the truck trailers to function as railcars when on rail. An example of this can be seen in Figure 2.5.


Figure 2.5: *Roadrailer train (Specialised trailers connected to bogies) (Trains, 2015)*

To withstand the forces encountered while on rail, the trailers need to be strengthened. This requires extra material and components to be added to the trailer which increases their tare weight. Even though the volume capacity of roadrailer trailers remains unchanged, the increased tare weight reduces the maximum allowable mass of the load being transported.

Roadrailers do not require large cranes like COFC but still require extra movements involving the positioning of rail bogies. This is unlike TOFC where the trailers can simply be driven onto the railcars. Therefore, roadrailers are more flexible than COFC but not as flexible as drive-on TOFC (Johnston and Marshall, 1993).

Roadrailer systems are not as widely used as the other bimodal solutions. This may be due to limited availability and lack of marketing (Johnston and Marshall, 1993). Many LSPs are therefore unfamiliar with the technology, especially in South Africa where such a system has never been implemented.

### 2.2.4 Summary of advantages and disadvantages of each bimodal system / technology

Table 2.1 summarises and compares the advantages and disadvantages of the different bimodal systems / technology.

TABLE 2.1: *Summary of advantages and disadvantages of different bimodal technologies*

| Bimodal systems / technology | Advantages | Disadvantages |
|---|---|---|
| COFC | • Widely used. | • Least flexible due to cranes required for loading;<br>• Requires expensive infrastructure. |
| TOFC:<br>Crane loading | • No need for truck trailers that can carry shipping containers. | Less flexible than roadrailers;<br>High centre of gravity on regular railcars. |
| TOFC:<br>Drive-on loading | • Most flexible method;<br>• Requires less expensive terminal infrastructure. | • Special railcars needed to lower centre of gravity;<br>• Extra weight of truck lowers weight of allowable freight. |
| Roadrailers | • More flexible than systems that use crane loading;<br>• Requires less expensive terminal infrastructure. | • Extra weight of the trailer limits weight of allowable freight;<br>• Many LSPs are unfamiliar with the technology;<br>• Sparsely used. |

## 2.3 Deregulation of freight transport in South Africa

Road transport overtook rail in the 1970s as the dominant form of long-distance transport in South Africa (excluding the mining sector) (Pienaar, 2007). The deregulation of freight transport in 1990 further decreased the market share of rail (Havenga, 2015). Rail transport is now mostly limited to major corridors and mining, while the use of branch lines is being neglected (CSIR, 2011). Figure 2.6 shows the corridor traffic increase and decrease in road and rail respectively from 1993 to 2008. The values in the graph were indexed from 1993 onwards. Rail market share has gradually decreased while road traffic has more than doubled.

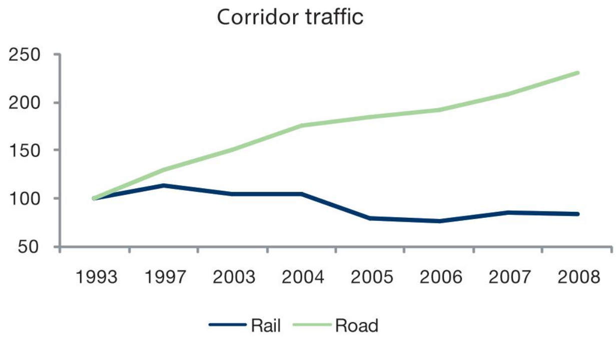


Figure 2.6: *Corridor traffic percentage increase and decrease in road and rail in South Africa (Ittman et al., 2009)*

## 2.4 Logistics costs in South Africa

The increase in road freight transport (as seen in Figure 2.6) is one of the major reasons why South Africa's logistics costs are higher than the global average (Havenga, 2010). In 2014 road transport contributed 83% to transport costs while rail transport contributed 15%.

The increase in road traffic requires a large amount of money to be spent on roads. In South Africa this amounted to 1.2%-1.6% of South Africa's GDP in 2010 to 2014. Other developed countries spent the equivalent of 0.1%-1.4% of their GDPs in the same time period (van Rensburg and Krygsman, 2019).

Furthermore, fuel prices (which are known to be volatile) are the major cost driver in logistics costs. This poses a big risk, especially to LSPs, since truck transport rates depend heavily on the price of fuel. This risk can be mitigated by using trains since they use less energy and run on electricity (Wolfsmayr and Rauch, 2014). Trains are therefore not affected by fluctuating fuel prices as severely as trucks are (Havenga, 2010).

## 2.5 Externalities of freight transport in South Africa

Another issue to consider is that of externality costs. These are costs to the environment, society and the economy that are not factored in to logistics costs. These costs include those of accidents, emissions, congestion, policing and noise.

Figure 2.7 shows that emissions are the biggest contributor to externality costs. In 2009 it was found that 20,3 million tonnes of GHG emissions were produced by road freight transport, while rail only produced 2.7 million tonnes (factoring in both diesel and electricity consumed by rail (CSIR, 2011)). This shows that road freight transport has a vastly larger carbon footprint than rail freight transport in South Africa.

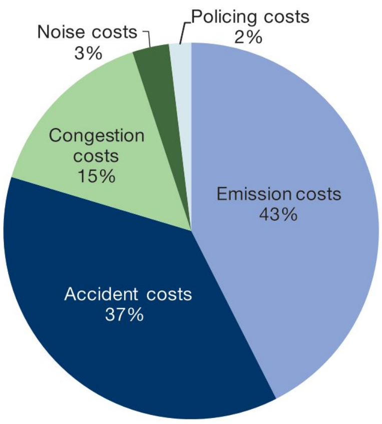


FIGURE 2.7: *Externality cost contributions of both road and rail in South Africa (Ittman et al., 2009)*

Most externality costs of freight transport in South Africa can be attributed to road as seen in Figure 2.8. The figure shows the percentage that road and rail contribute to the total externality costs in South Africa. Rail contributes only 4% to the total amount. Rail is less severely affected by externality costs than road. Therefore, the shift of freight transport from road to rail could significantly lower the total transport externality costs of South Africa.

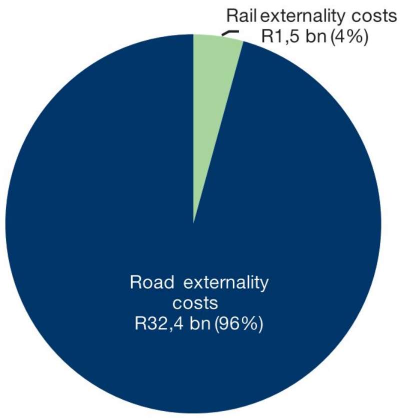


FIGURE 2.8: *Externality cost contributions of road and rail in South Africa (Ittman et al., 2009)*

## 2.6 Freight flows in South Africa

Figures 2.9, 2.10 and 2.11, show the transport flow densities of agriculture, manufacturing, and mining in 2014 respectively. Thicker lines on the figures represent freight flows with higher densities. It must be noted that large freight flows such as these see few, if any, changes in routes.

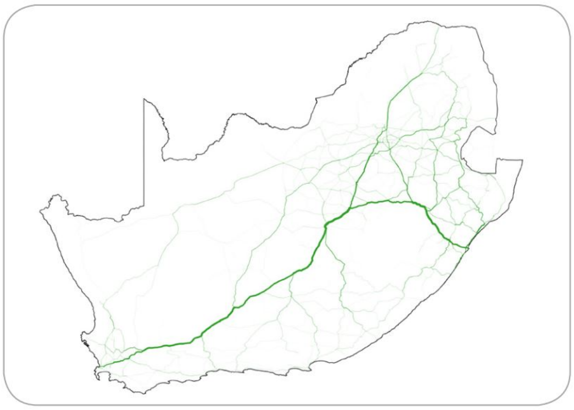

Figure 2.9: *Agriculture transport density flow in South Africa in 2014 (Havenga, Z. P. Simpson, King, D. de Bod, et al., 2016)*

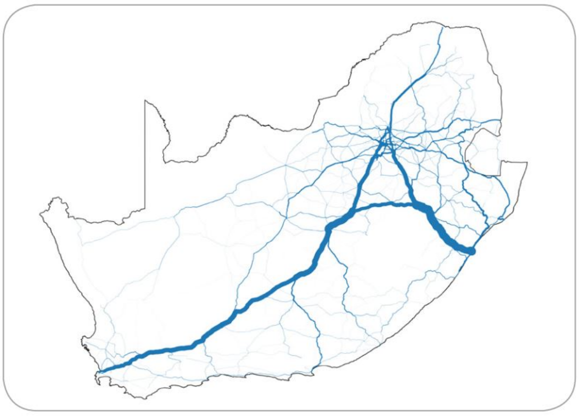

Figure 2.10: *Manufacturing transport density flow in South Africa in 2014 (Havenga, Z. P. Simpson, King, D. de Bod, et al., 2016)*

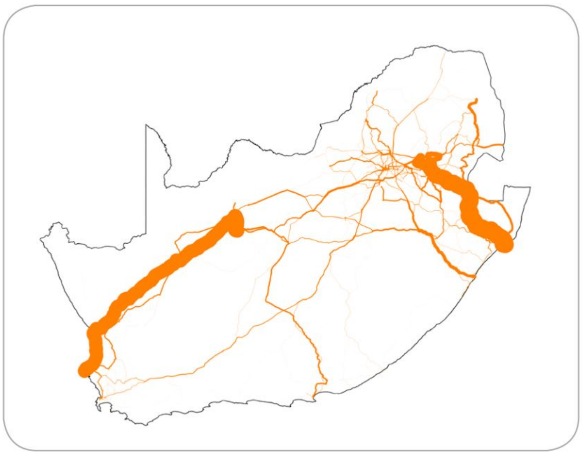

Figure 2.11: *Mining transport density flow in South Africa in 2014 (Havenga, Z. P. Simpson, King, D. de Bod, et al., 2016)*

Figures 2.9 and 2.10 show dense freight flows of agriculture and manufacturing on the Cape

Town-to-Gauteng corridor (Capecor) and KwaZulu-Natal-to-Gauteng corridor (Natcor). Figure 2.11 Shows that there is a dense freight flow of mining exports travelling through Richards Bay and Saldanha. This freight flow primarily consists of rail transport.

## 2.7 Percentage of rail-friendly freight in South Africa

Figure 2.12 shows that 10% of all freight (15% of road freight) in terms of tonnes, and 11% of all freight (21% of road freight) in terms of tonne-km is rail-friendly (freight that can be easily transported on rail) (Havenga and Z. P. Simpson, 2016). If this rail-friendly freight were to be transported on rail, South Africa's logistics costs would decrease considerably.

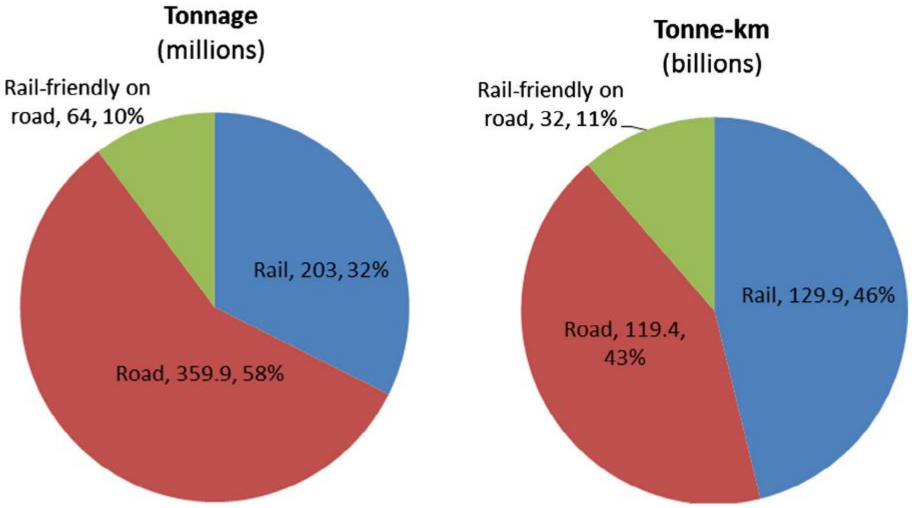


FIGURE 2.12: *Rail-friendly freight on road in 2013 (Havenga and Z. P. Simpson, 2016)*

## 2.8 The case for use of bimodal transport in South Africa

Long-distance transport in South Africa is dominated by road transport (Van Eeden and Havenga, 2010). However, long-distance freight is much better suited to rail transport. Ideally trucks would do the collection and distribution of freight and rail would be used for the high-density, long-distance transport segment (Van Eeden and Havenga, 2010) However, the development of road-to-rail bimodal solutions in South Africa has been neglected (Havenga, Z. P. Simpson, Fourie, et al., 2011).

As discussed in Sections 2.3 — 2.7, there is a considerable amount of freight that can be transported by rail in South Africa. If this were to be done, South Africa could see a major decrease in its logistics and transport externality costs. Therefore, it would be highly advantageous for a bimodal solution to be developed and utilised in South Africa.

## 2.9 Choice of mode of transport in South Africa

Five years after the deregulation of the freight transport industry in South Africa, Andersen (1995) did a study to determine the most important criteria for modal choice. Table 2.2 shows the top five criteria and the weight of their importance.

Table 2.2: *Modal choice criteria and preference (Andersen, 1995)*

| | | Modal preference | |
|---|---|---|---|
| Modal choice criteria | Weight (%) | Road (%) | Rail (%) |
| Customer requirements (Flexibility) | 26,0 | 73 | 27 |
| Service reliability | 23,6 | 81 | 19 |
| Loss and damage (Goods security) | 18,6 | 77 | 23 |
| Total throughout | 16,1 | 83 | 17 |
| Transport cost | 15,7 | 52 | 48 |

The table shows that customer requirements (flexibility), service reliability, loss and damage (goods security), total lead time and transport cost are the most important choice criteria. Surprisingly transport cost was found to be the least important of the five criteria. It also shows that the perception of the performance of rail was far worse compared to road in most cases except transport cost, where road and rail were almost equal.

A similar study done by Anderson and Basson (1997) on the modal choice for the transport of bottled beverages found that the following criteria are considered important (ordered from most important to least important):

- Service reliability;
- Total transit time;
- Flexibility;
- Goods security;
- Transport price;
- Availability of a communication system to track shipments during transit.

Furthermore, Vogt et al. (2005) did a study by surveying six shippers, 15 long-distance carriers and five freight owners of semi-finished and finished goods. The survey concluded that road was the preferred method of transport, even if rail were the cheaper option, in the following cases:

- When the goods are:
  - Perishable;
  - Subject to rapid ageing;
  - Required on short notice;
  - Valuable in relation to their mass;
  - Expensive to handle or store.
- When the demand for the goods:
  - Is unpredictable;
  - Occurs infrequently;

  - Is more than the local supply for short periods;
  - Is seasonal.

- When the following problems occur during distribution:
  - Risk of theft, breakage, or physical deterioration;
  - High insurance and/or interest cost for long lead times;
  - Heavy or expensive packaging is required for rail transport.

This shows that LSPs and freight owners find many other factors important other than just cost per tonne-km or cost per km.

## 2.10 Criteria for viable bimodal transport in South Africa

For rail transport to be profitable in South Africa, some criteria have to be met. First, Havenga, Z. P. Simpson, Fourie, et al. (2011) stated that the travel distance between the origin and destination of freight must be at least 500 km for rail to be cheaper than road. This is the distance at which the extra cost of shifting the freight from road to rail is negated by the cheaper transport costs of rail over long distances (Pienaar, 2007).

Tonne-kilometre or tonne-km is the standard unit of measurement used in the rail transport industry. It is calculated by multiplying the number of tonnes transported by the distance that it travels over. Since rail transport has high fixed costs, the cost per tonne-km decreases as the number of tonne-km increases. Therefore, there is also a minimum amount of freight that needs to be transported for rail to be cheaper than road. This amount has been found to be 100 000 tonnes of freight per annum transported over a minimum transport distance of 500 km (Havenga, Z. P. Simpson, Fourie, et al., 2011).

Transport density is calculated by dividing the tonne-km of a route by the distance of that route (tonne-km/route-km). The main driver of this transport density is the unitisation of freight. This is when freight can be transported in uniform standardised forms such as pallets. This makes it easier for freight to be placed in shipping containers that can be transported using bimodal methods. Therefore, unitisation or palletisation is also seen as a key criterion for viable bimodal freight transport (Havenga, Z. P. Simpson, Fourie, et al., 2011).

An increase in transport density also causes the standardisation of systems and processes. This standardisation results in cost savings through increased efficiency (Harris, 1977). Harris (1977) showed that rail has high fixed costs compared to road but low running costs. Therefore, the cost of rail transport in cost per tonne-km decreases as the density (measured in tonne-km) increases. This relationship is demonstrated in Figure 2.13.

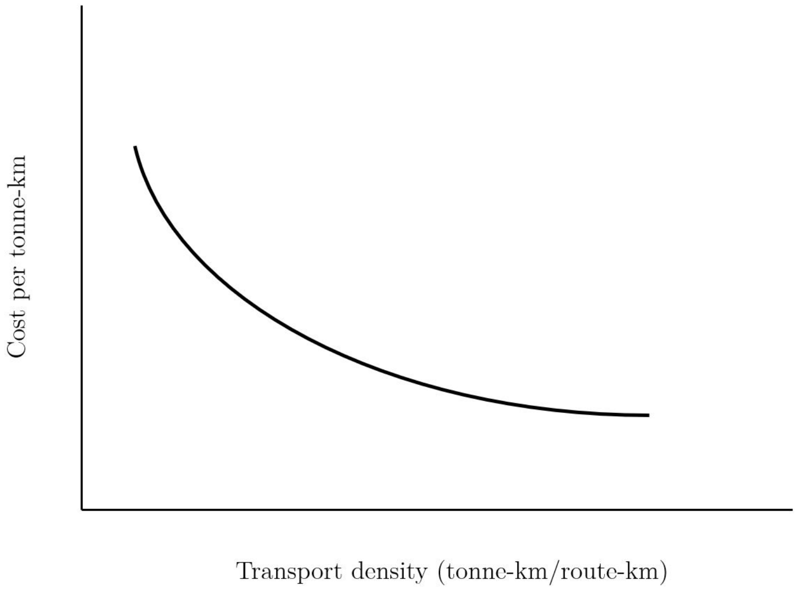


Figure 2.13: *Transport density vs cost per tonne-km (Harris, 1977)*

## 2.11 Commodities best suited for bimodal transport in South Africa

In South Africa, rail is primarily known for the transportation of bulk commodities (Havenga, Z. P. Simpson, Fourie, et al., 2011). Pienaar (2007) states that the following goods are known to be transported in long-distance road freight transport:

- Certain organic primary products (such as agriculture);
- Some semi-finished goods;
- Many finished goods;
- Most consumer goods.

The emerging pattern is that products that are closer to the finished form that end users consume, the more likely they are to be transported via road.

Table 2.3 and 2.4 show the top commodities transported over the Capecor and Natcor. One can see that rail has a higher market share in the transport of bulk commodities like iron, steel, wheat, motor vehicles, maze, jet fuel and coal. The volumes of these commodities are also predicted to increase by the year 2050. This provides a level of certainty that there will still be a need for transport of these commodities well into the future.

TABLE 2.3: *Natcor freight volumes*

| Commodity | Billion tonne-km (2019) | Rail market share | % of corridor | Billion tonne-km (2050) |
|---|---|---|---|---|
| Processed Foods | 2,4 | 1% | 17% | 5,2 |
| Chrome | 2,0 | 7% | 14% | 5,8 |
| Chemicals | 1,0 | 28% | 7% | 2,0 |
| Other Manufacturing Industries | 0,9 | 0% | 6% | 1,7 |
| Beverages | 0,8 | 0% | 5% | 1,6 |
| Iron & Steel | 0,5 | 66% | 4% | 0,8 |
| Other Petroleum Products | 0,5 | 3% | 3% | 0,3 |
| Other Agriculture | 0,5 | 0% | 3% | 1,0 |
| Wheat | 0,4 | 39% | 3% | 0,7 |
| Motor vehicles and trucks | 0,4 | 49% | 3% | 0,9 |
| Other Mining | 0,4 | 0% | 3% | 0,7 |
| Jet fuel | 0,4 | 65% | 3% | 1,0 |
| Metal products, machinery and electronic equipment | 0,3 | 0% | 2% | 0,8 |
| Motor Vehicle Parts & Accessories | 0,3 | 0% | 2% | 0,9 |
| Paper | 0,3 | 0% | 2% | 0,5 |
| Cement | 0,3 | 3% | 2% | 0,6 |
| Scrap metals | 0,3 | 0% | 2% | 0,4 |
| Animal feed | 0,3 | 0% | 2% | 0,5 |
| Other commodities | 2,4 | 6% | 16% | 4,0 |

Table 2.4: *Capecor freight volumes*

| Commodity | Billion tonne-km (2019) | Rail market share | % of corridor | Billion tonne-km (2050) |
|---|---|---|---|---|
| Processed Foods | 4,7 | 0% | 26% | 10,9 |
| Other Manufacturing Industries | 1,7 | 9% | 10% | 2,5 |
| Beverages | 1,6 | 0% | 9% | 3,8 |
| Diesel | 1,3 | 0% | 7% | 0,6 |
| Cement | 1,1 | 1% | 6% | 2,3 |
| Limestone | 0,8 | 23% | 4% | 1,8 |
| Iron & Steel | 0,7 | 47% | 4% | 1,1 |
| Animal feed | 0,6 | 0% | 3% | 1,2 |
| Other Agriculture | 0,5 | 0% | 3% | 1,2 |
| Metal products, machinery and electronic equipment | 0,5 | 0% | 3% | 0,9 |
| Maize | 0,4 | 30% | 2% | 1,3 |
| Slaughtered animal meat | 0,4 | 0% | 2% | 0,9 |
| Paper | 0,3 | 0% | 1% | 0,4 |
| Chemicals | 0,2 | 0% | 1% | 0,4 |
| Scrap metals | 0,2 | 0% | 1% | 0,3 |
| Milk (bulk) | 0,2 | 0% | 1% | 0,4 |
| Other commodities | 2,7 | 9% | 15% | 6,7 |

Van Eeden and Havenga (2010) found the following five commodities to be the most suitable for intermodal transport in South Africa:

- Processed foods;
- Beverages;
- Chemicals (other);
- Paper and paper products;
- Wood and wood products.

These commodities are easily unitised / palletised which makes them good candidates for intermodal transport as explained in section 2.10. These commodities also make up a considerable percentage of corridor freight transported in South Africa. If rail increases its market share by 50% for these five commodities, then its overall market share on the Capecor could increase over six times, and its market share on the Natcor would double (Van Eeden and Havenga, 2010).

## 2.12 Key research paper: Truck Operating Benchmarks

The paper discussed in this section provides key information for the construction of the financial model in the preliminary toolkit.

An important part of the toolkit is the comparison of costs for different transport methods. A financial model aids in calculating and displaying all the costs involved. In 2019, Braun (2019) developed a guide for truck operating costs. This can be used as a basis for comparing the operating costs of transport methods involving road only transport and transport involving the use of RailRunner technology. Max Braun as one of the country's foremost experts on all aspects of acquiring, owning and operating trucking fleets and road transportation of a wide range of goods.

Table 2.5 shows the different variables and values that this guide considers. These values are based on the use of a Superlink (7-axle articulated vehicle) which is the industry standard vehicle for long-distance road transport in South Africa.

TABLE 2.5: *Truck operating benchmarks*

| Variable | Value |
|---|---|
| Assumptions | |
| Number of axles | 7 |
| Vehicle type | Articulated Superlink |
| Payload (tons) | 34 |
| Deck length (Metres) | 18 |
| Pallets | 36 |
| Annual KM | 180 000 |
| Working days | 286 |
| Useful life (km) | 800 000 |
| Economic Life (Years) | 5 |
| Capital cost | |
| Prime Mover | 1 900 000 |
| Auxiliary Equipment | - |
| Trailer | 616 000 |
| Other | - |
| **TOTAL CAPITAL COST** | 2 516 000 |
| Standing cost | |
| Prime Mover Depreciation | 380 000 |
| Auxiliary Depreciation | - |
| Trailer Depreciation | 61 600 |
| **Total Depreciation** | 441 600 |
| Cost of capital | 161 074 |
| Prime Mover Licence | 20 145 |
| Trailer Licence | 17 280 |
| **Total Licence Fee** | 37 425 |
| **Total Insurance** | 176 120 |
| Driver Wages | 339 034 |
| Assistant Wages | 114 000 |
| **Total Wages** | 453 034 |
| **TOTAL STANDING COST** | 1 269 253 |

**Table 2.5 continued from previous page**

| Variable | Value |
|---|---|
| **As a % of Total Cost** | 34,93% |
| Variable cost | |
| Prime mover fuel | 1 509 943 |
| Auxiliary fuel | - |
| **Total Fuel** | 1 509 943 |
| Top-up Oil | 75 497 |
| Prime Mover Repair & Maintenance | 320 400 |
| Auxiliary Repair & Maintenance | - |
| Trailer Repair & Maintenance | 180 000 |
| **Total Repair & Maintenance** | 500 400 |
| **Total Tyres** | 153 360 |
| Unforeseen Expenses | 125 000 |
| **TOTAL VARIABLE COST** | 2 364 200 |
| **As a % of Total Cost** | 65,07% |
| **TOTAL OPERATING COSTS** | 3 633 453 |
| Summary | |
| Standing Cost (Rands per/day) | 4 438 |
| Standing Cost (Rands/Km) | 7,05 |
| Variable Cost (Rands/Km) | 13,13 |
| **Total CPK (Rands/Km)** | 20,19 |
| Cost per Ton/Km (100% Load) | 0,59 |
| Cost per Ton/Km (75% Load) | 0,79 |
| Cost per Ton/Km (50% Load) | 1,19 |

## 2.13 Chapter Conclusion

This chapter looks at different types of bimodal systems and technology and the advantages and disadvantages of each. A case for the use of bimodal technology in South Africa is also created. This is done by first looking at the positives and negatives of using rail and road respectively. Secondly the percentage of rail-friendly freight on road is used to conclude that South Africa would be better off using bimodal transport for long-distance freight transport.

The choice of mode of transport is explored to see what LSPs and freight owners find important when it comes to the transport of freight. Criteria for viable bimodal transport is also explored to see what requirements transport needs to fulfil to be able to save costs. Lastly, commodities best suited for bimodal transport are discussed.

The information in this chapter merely gives background to the road and rail industry in South Africa. However, there are still some important topics that need to be discussed to be able to set up selection criteria and a preliminary toolkit for potential users of the RailRunner system. This discussion would be best done in the form of a structured literature review so that it can be transparent and repeatable. The following research questions need to be answered in an unbiased and objective manner:

1. What freight commodities are transported using bimodal transport in other countries?
2. Under what circumstances are these commodities transported using bimodal transport?

3. What are the main challenges that road-to-rail bimodal transport faces?
4. What factors do companies find important when it comes to the transportation of their goods?
5. What characteristics of the RailRunner system would influence the suitability of its use in South Africa?

Chapter 3 discusses and answers these questions.

# CHAPTER 3

# Structured literature review (SLR)

Contents



## 3.1 Introduction

The aim of this Systematic Literature Review (SLR) is to answer questions relating to bimodal road-to-rail transport (identified in Chapter 2) in a way that is both transparent and repeatable.

The primary research question, (the formulation of which is discussed in section 3.2), is as follows:

*What tools are required to aid in the decision-making of an LSP to shift from road-only transport to road-to-rail bimodal transport (more specifically, in the form that RailRunner provides)?*

This chapter will build on Chapter 2 and help to establish selection criteria that can be used to identify potential logistics service providers (LSPs) that would benefit from using bimodal technology. It also helps to establish a preliminary toolkit that LSPs will be able to use to assess whether they would be able to benefit from using bimodal technology.

## 3.2 Methodology

This section describes the methods used to formulate a primary research question and how literature sources were obtained that can be used to answer that question. The structure and methodology of this chapter takes similarities from Kitchenham (2007).

### 3.2.1 Formulating a primary research question

A well-defined research question can help guide a literature review. It has a major influence on the outcome of the overall literature review. Having a single primary research question reduces the scope and the number of literature sources that need to be reviewed. This is because hundreds, or even thousands of sources may need to be reviewed to answer every research question defined. Therefore, this review has one primary research question and multiple secondary research questions. This allows one to gather a smaller number of sources for each secondary question that also all contribute to answering the primary research question. Table 3.1 shows the secondary research questions that serve as input questions to the primary research question and the finalised primary research question.

TABLE 3.1: *Input questions to the primary research question*

| **Input to primary research question** |
|---|
| Under what circumstances are these commodities transported using bimodal transport? |
| What are the main challenges that road-to-rail bimodal transport faces? |
| What factors do companies find important when it comes to the transportation of their goods? |
| What characteristics of the RailRunner system would influence the suitability of its use in South Africa? |
| **Primary research question** |
| What tools are required to aid in the decision-making of an LSP to shift from road-only transport to road-to-rail bimodal transport (more specifically, in the form that RailRunner provides)? |

### 3.2.2 Gathering relevant literature sources

In order to find relevant literature, one must start by gathering a large set of sources that can then be filtered down. The searching and filtering process must be unbiased, transparent and repeatable. This section will discuss the gathering and filtering process used to find relevant literature for this thesis. The following five steps will be taken:

1. Acquiring sources by searching through databases;
2. Removing of duplicates;
3. Rejecting sources with unwanted strings in the title, keywords, and abstract;
4. Accepting only sources with vital keywords in the abstract;

5. Final inclusion criteria (written in English, full text available, topic is relevant, no (leftover) duplicates).

### Gathering of literature sources

To find relevant literature, one must construct search strings to use when searching in the identified databases. The following process describes the construction and the use of these search strings to find relevant sources.

First, keywords and synonyms are listed that relate to the secondary research questions. Search string segments are then generated using the keywords and synonyms as seen in Table 3.2. The full list of keywords and synonyms can be seen in Appendix A.1.

TABLE 3.2: *Search strings made from keywords*

| Keyword | road | rail | Intermodal | challenges |
|---|---|---|---|---|
| Synonyms | truck | train | bimodal | challenge |
| | | | roadrailer | problems |
| | | | bi-modal | problem |
| | | | Inter-modal | hurdles |
| | | | modal shift | |
| Search string segments | ("road" OR "truck") | ("rail" OR "train") | ("Intermodal" OR"bimodal" OR"roadrailer" OR"bi-modal" OR"Inter-modal" OR"modal shift") | ("challenges" OR"challenge" OR"problems" OR"problem" OR"hurdles") |

Secondly, each research question is listed and keywords (or overarching topics) that relate to these questions are selected. Using the search string segments generated from these keywords (as previously explained and shown in Table 3.2) full search strings are generated. These search strings are then used to search for literature sources in different databases. The databases that were searched include Scopus, ScienceDirect, Web of Science and EBSCO Host. Filters were applied to these searches to refine the results. An example of this can be seen in Table 3.3. The full table (including the date accessed and filters applied) can be seen in Appendix A.2.

TABLE 3.3: *Search string search results*

| Question | Overarching topics (keywords) | Search string | Database | Filters applied | Number of results |
|---|---|---|---|---|---|
| What freight commodities are transported using bimodal transport in other countries? | road<br>rail<br>commodities<br>intermodal | (“road” OR “truck”) AND (“rail” OR “train”) AND (“Intermodal” OR “bimodal” OR “roadrailer” OR “bi-modal” OR “Inter-modal” OR “modal shift”) AND (“materials” OR “goods” OR “commodities” OR “products”) | Scopus | Search in title abstract and keywords | 242 |
| | | | ScienceDirect | Title, abstract or author-specified keywords | 78 |
| | | | Web of Science | None | 83 |
| | | | EBSCO Host | Databases: Academic Search Premier, AfricaWide Information, MasterFILE Premier, Regional Business News, Business Source Premier<br>Search field: Abstract<br>Limit results to: Academic Journals | 203 |
| What characteristics of the RailRunner system would influence the suitability of commodities transported? | intermodal<br>criteria<br>transport<br>commodities | (“Intermodal” OR “bimodal” OR “roadrailer” OR “bi-modal” OR “Inter-modal” OR “modal shift”) AND (“transport” OR “transportation” OR “transported”) AND (“criteria” OR “choice” OR “determining factors”) AND (“materials” OR “goods” OR “commodities” OR “products”) | Scopus | Search in title abstract and keywords | 103 |
| | | | ScienceDirect | Title, abstract or author-specified keywords | 141 |
| | | | Web of Science | None | 44 |
| | | | EBSCO Host | Databases: Academic Search Premier, AfricaWide Information, MasterFILE Premier, Regional Business News, Business Source Premier<br>Search field: Abstract<br>Limit results to: Academic Journals | 96 |

### Filtering of gathered sources

Once the sources were extracted from the databases, the duplicate results were removed. The source's titles, keywords and abstracts were then checked to see if they had any unwanted strings. These strings were selected so that irrelevant papers could be excluded. Sources that focused on public transport, simulations, electrical or electronic aspects of transport, or any mode of transport other than road and rail were excluded. The unwanted strings, as seen in Table 3.4, were used.

TABLE 3.4: *Unwanted strings*

| Category | Other modes of transport | Public transport | Simulations | Electrical or electronic |
|---|---|---|---|---|
| Unwanted strings of text | maritime | passenger | simulat | electr |
| | sea | public transport | model | |
| | ship | people | | |
| | Pipe | | | |
| | shipping | | | |
| | Air | | | |
| | Plane | | | |
| | naval | | | |
| | marine | | | |

A higher concentration of relevant sources was retained once the sources containing unwanted strings were excluded. All the abstracts were then manually checked to see which sources are relevant. All the irrelevant sources were flagged manually. A preliminary list of vital keywords (that each source must contain in its abstract to be relevant) was then set up. This was done by comparing relevant sources to irrelevant sources and selecting preliminary vital keywords by hand. Using an algorithm, the sources were checked to see if they contained at least one of these preliminary vital keywords. If they did not contain any of the preliminary vital keywords, then they were flagged by the algorithm. An example of this process can be seen in Table 3.5. Through a process of trial and error, the vital keywords were changed so that the sources flagged by the algorithm best matched the sources that were flagged manually. This was done so that the subjective nature of excluding irrelevant sources by hand could be avoided. This way irrelevant sources were identified by an unbiased algorithm. The following final list of vital keywords was used to remove irrelevant sources:

- Freight;
- Trade;
- Truck;
- Commodities;
- Terminal;
- Infrastructure;

- Trains;
- Rail.

TABLE 3.5: *Vital keyword searching*

| Source | Keywords | | | | Flag | |
|---|---|---|---|---|---|---|
| Abstract | truck | infrastructure | trains | rail | Number of vital keywords | Flag |
| The paper... | 0 | 1 | 0 | 0 | 1 | |
| The risk... | 1 | 0 | 0 | 1 | 2 | |
| A road... | 0 | 0 | 0 | 0 | 0 | X |
| Bateman... | 1 | 0 | 1 | 0 | 2 | |

**Number of sources rejected in filtering process**

Altogether 56 useful sources were extracted from the screening process. The number of sources that were accepted and rejected in the process can be seen in Figure 3.1. The final list of sources can be seen Appendix A.3.

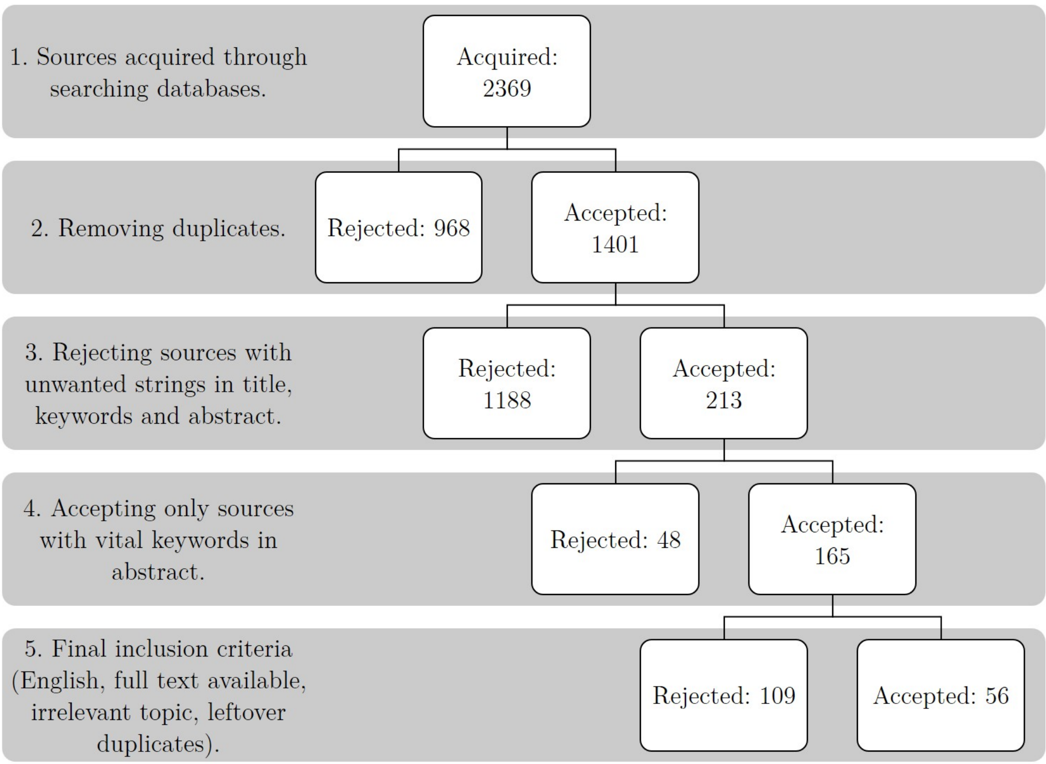


FIGURE 3.1: *Number of sources that were accepted and rejected in the screening process*

## 3.3 Characteristics of literature sources gathered

The 56 sources that were acquired, varied in terms of the year that they were published and the geographical area in which they are relevant. This is shown in Figures 3.2 and 3.3, respectively.

Figure 3.2 was made by looking at how many papers were published within one-year intervals and then plotting that information in a graph. The graph shows that the sources have mostly been published in the last twenty years. The freight transport industry is one of minor change and relatively slow innovation, so the sources can be seen as relevant to bimodal transport today.

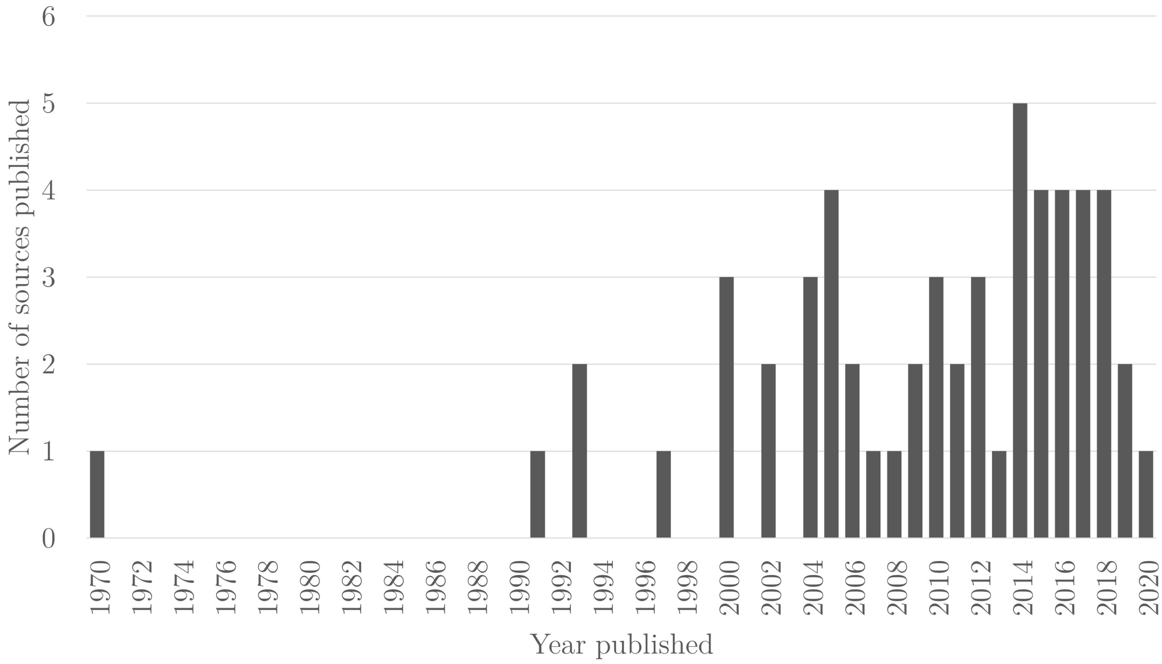


FIGURE 3.2: *Dates that sources were published*

Figure 3.3 is made by reading each paper and looking at where the paper was written, and the geographical area in which it was relevant. This data was then compiled, and a pie graph was constructed showing what portion of the papers were relevant to which geographical area. The figure shows that the sources are relevant to many geographical areas. Most of the sources have a focus on bimodal transportation in Europe. This could be because of Europe's extensive and stable rail infrastructure.

Figure 3.4 shows a table that was constructed to show keywords mentioned in certain contexts in the sources. The papers were each assigned a unique identification number that can be seen in the top row of the table. These papers were then scanned for keywords using the search feature in Mendeley. These keywords can be seen in the column labelled "keyword". Furthermore, the keywords were grouped into the context in which they were used. This can be seen in the column labelled "Context". Within the context of train commodities, seven categories were defined as seen in the column labelled "Category". The total number of times that keywords were mentioned in these categories are displayed underneath the category labels. The final row of the table shows the number of times a source contains one of the keywords in a certain context. This is used to gauge the relevance of the source to this paper. The sources were arranged from left to right according to this total. The totals in the right-hand column show the number of times a keyword is mentioned. If the keyword is mentioned in more sources, then its significance within a certain context is seen as higher.

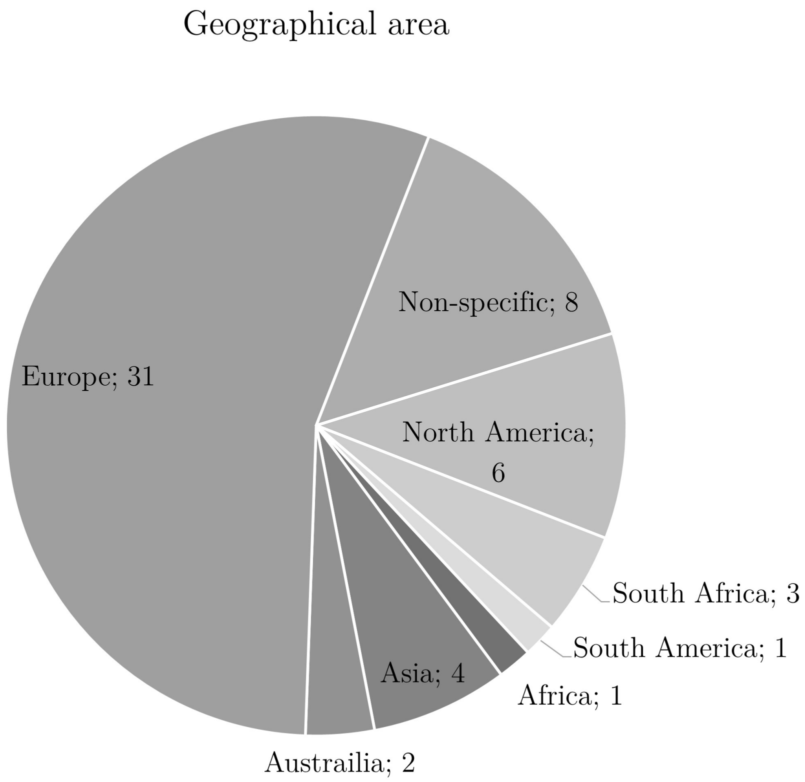


FIGURE 3.3: *Geographical focus areas of sources*

| Context | Category | Paper ID / Keyword | 4 | 15 | 43 | 33 | 31 | 36 | 48 | 3 | 27 | 5 | 51 | 22 | 25 | 16 | 53 | 7 | 24 | 47 | 19 | 26 | 45 | 13 | 37 | 49 | 9 | 29 | 1 | 10 | 18 | 42 | 56 | 11 | 12 | 21 | 34 | 35 | 44 | 46 | 2 | 8 | 17 | 28 | 30 | 52 | 6 | 14 | 20 | 23 | 32 | 38 | 39 | 40 | 41 | 50 | 54 | 55 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Rail characteristics | | long distance | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 20 |
| | | safe | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 12 |
| | | large/high volumes | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 |
| | | fuel efficient | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 |
| | | slow/ long dwell times | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| | | not time-sensitive | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| | | cost effective | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| | | unsafe | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Train commodities | bulk | shipping containers | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 23 |
| | | bulk | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 16 |
| | 42 | waste | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| | mining | coal | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 13 |
| | | mining | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 |
| | | ore | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| | 26 | minerals | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 5 |
| | raw materials | wood / forestry / lumber | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 |
| | | chemicals | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 |
| | | raw materials | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| | | metal | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| | 21 | clay, concrete, glass or stone | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| | agriculture | agriculture | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 |
| | | grain | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| | 13 | wheat | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| | FMCG | food | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 |
| | | kindred products | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| | | low value goods | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| | 11 | consumer goods | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| | fuel | petroleum | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| | | gas | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| | 7 | crude oil | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| | high value goods | machinery | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| | | high value goods | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| | 8 | equipment | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| Road characteristics | | flexibility | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 12 |
| | | door to door | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9 |
| | | reliability | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| | | low investment costs | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| | | high value goods | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| Positives of road to rail | | less traffic / congestion | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 15 |
| | | less pollution | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 11 |
| | | less accidents | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 |
| | | reduce environmental impact | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 8 |
| | | reduce CO2 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 |
| | | lower externalities | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 |
| | | smaller social impact | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| Bimodal challenges | | sidings / infrastructure | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 20 |
| | | flexibility | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 |
| | | high investment costs | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 |
| | | reliability | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 |
| | | frequency of services | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 |
| | | accessibility | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| Transport criteria / requirements | | reliability | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 |
| | | time / punctuality | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 |
| | | frequency | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| | | low price / cost | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| | | flexibility | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| | | safety / security | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| | | accessibility | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| | | information | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| | | Total | 21 | 19 | 18 | 17 | 16 | 16 | 15 | 14 | 14 | 13 | 13 | 11 | 11 | 9 | 9 | 8 | 8 | 8 | 7 | 7 | 7 | 6 | 6 | 6 | 5 | 5 | 4 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | |

FIGURE 3.4: *Keywords mentioned in certain contexts in the sources*

Conclusions will be drawn from the information contained in Figure 3.4 in Section 3.4. A closer look will also be taken at the sources that were used in the figure.

## 3.4 Meta-analysis discussion

The following discussion relates to Figure 3.4. Each subsection relates to the different contexts as seen in the "Context" column in the figure. These discussions will provide answers to the research questions as seen in Section 3.1.

### 3.4.1 Train Characteristics

From the keywords mentioned in the context of "Train characteristics", one can see that trains are best utilised for long-distance transport of high volumes. Pinto et al. (2018) states that trains do not have the same reach or flexibility as trucks, but their characteristics favour the transport of great quantities over long distances. Wolfsmayr and Rauch (2014) states that energy consumption and transport costs are lower for long-distance transport if trains are used compared to trucks.

The shift from road to rail adds cost due to the extra operations required to shift the freight from trucks to trains at terminals. Bimodal transport should therefore only be considered for long-distance, high-volume transport to compensate for the extra cost (Behrends, 2017). Furthermore, the use of rail transport is attractive for companies that are close to terminals and that are flexible when it comes to transport times (González, Sánchez, and Romero, 2014).

In South Africa, rail-friendly freight is defined as freight transported between origin destination pairs with volumes of 100 000 tons per annum (which amounts to a minimum of one train per week) over a transport distance of more than 500 km (Havenga, Z. P. Simpson, and de Bod, 2012b). Similarly, 500 km is also the distance at which bimodal transport becomes competitive in Europe (Behrends, 2017).

Trains are also much safer in terms of accidents since trucks have a higher chance of being involved in road accidents (Bubbico, Di Cave, and Mazzarotta, 2004). This is especially important for the transportation of hazardous materials, where trains remain the safest option (Rada, Ferronato, and Torretta, 2017).

This subsection provides an answer to the second research question mentioned in Section 3.1: "Under what circumstances are these commodities transported using bimodal transport?". It also helps answer the fifth research question: "What characteristics of the RailRunner system would influence the suitability of its use in South Africa?". This is because it provides insight into the characteristics of RailRunner that is like that of rail transport.

### 3.4.2 Road Characteristics

Freight transportation by truck is more flexible than train (Pinto et al., 2018) and specialises in door-to-door transport. This is since trucks are not limited to travelling on a track as trains are. Trucks can move on any country's roads (Pinto et al., 2018), unlike trains that need a track of a specific gauge. Trucks are also more flexible because they can move freight independently of other freight. Trains usually have multiple payloads, destined for multiple locations, that all need to be transported at once. This limits trains' flexibility since payloads with different origin-destination pairs must be transported together, and at the same time.

Trucks also have the advantage of not being limited by the place of loading and unloading. Trucks can therefore provide door-to-door transport (Černá, Zitrický, and Daniš, 2017). The only way trains can provide door-to-door transport is if the customer owns a private siding (González, Sánchez, and Romero, 2014). Road-to-rail transport involves multiple modal transfers whereas pure road transport does not. This results in the greater reliability of truck transport (Islam, Jackson, and Robinson, 2015). These modal transfers also increase cost and transit time.

In general, trucks are the most popular form of transport due to their superior reach, flexibility, speed, low investment cost and low operating costs. The low operating costs of trucks are because of simplified maintenance and handling requirements (especially on shorter routes) (Pinto et al., 2018).

This subsection helps answer the fifth research question mentioned in Section 3.1: "What characteristics of the RailRunner system would influence the suitability of its use in South Africa?". This is because it provides insight into the characteristics of RailRunner that are like those of road transport.

### 3.4.3 Train Commodities

As seen in Figure 3.4 the commodities (and the number of papers mentioning those commodities) that trains most commonly transport fall into the categories seen in Table 3.6:

TABLE 3.6: *Commodities transported by train in sources*

| Category | Keywords | Number of mentions |
|---|---|---|
| bulk | shipping containers, bulk, waste. | 42 |
| mining | coal, mining, ore, minerals. | 26 |
| raw materials | wood / forestry / lumber, chemicals, raw materials, metal, clay / concrete / glass / stone. | 21 |
| agriculture | agriculture, grain, wheat. | 13 |
| FMCG | food, kindred products, low value goods, consumer goods. | 11 |
| fuel | petroleum, gas, crude oil . | 7 |
| high value goods | machinery, high value goods, equipment. | 8 |

By looking at Table 3.6 one can get an idea of what commodities are most commonly transported by trains by looking at the number of times they were mentioned in the sources. A greater number of mentions implies that the commodities are more likely to be transported by rail.

Picinin et al. (2011) states that the loads typical of rail transport are: steel products, grain, iron ore, cement, fertilizers, petroleum, coal, and shipping containers. In Europe commodities transported by rail include agricultural products, foodstuffs, solid mineral fuels (coal), petroleum products, ores and metal waste, metal products, manufacturing and building materials, fertilizers, chemicals, machinery, and transport equipment (Islam, Jackson, and Robinson, 2015). The emerging pattern is that commodities resembling bulk and raw materials are more likely to be transported by rail.

This subsection provides an answer to the first research question mentioned in Section 3.1: "What freight commodities are transported using bimodal transport in other countries?".

### 3.4.4 Positives of moving from road-only to bimodal transport

Figure 3.4 clarifies the positives of moving from road-only to bimodal transport. Pinto et al. (2018) states that using trucks for transport has inherent disadvantages, such as susceptibility to traffic, accidents, breakdowns, limited load capacity and high GHG emissions. Trucks also produce noise pollution and congestion which have a negative social impact on citizens' lives (Nocera, Cavallaro, and Irranca Galati, 2018). These factors contribute to the externality costs of road transport as well as having a negative impact on the economy. These externality costs can be mitigated by using bimodal transport. Furthermore, by looking at Figure 3.4 it is apparent that trains have less of an environmental impact due to fewer GHG emissions.

This subsection helps answer the fifth research question mentioned in Section 3.1: "What characteristics of the RailRunner system would influence the suitability of its use in South Africa?". This is because it provides insight into the positives of using bimodal systems like RailRunner.

### 3.4.5 Bimodal challenges

One of the challenges of using bimodal transport includes the need for infrastructure such as sidings and rail networks (Pinto et al., 2018). Traditional road-to-rail freight transportation requires large cranes and expensive equipment. This results in high investment costs (Guo et al., 2018). South Africa has an extensive rail network, but unfortunately the development and maintenance of terminal infrastructure and branch railway lines have been neglected (CSIR, 2011).

Reliability was one of the main factors that companies found important regarding freight transport (A. S. Fowkes, Nash, and Tweddle, 1991). Due to the extra movement that freight has to go through in bimodal transport, the chance of delays is increased. The chance of theft also increases due to the freight having to be stored at terminals with limited supervision.

Flexibility and frequency of services is also one of the challenges faced in road-to-rail transport (Roso, Brnjac, and Abramovic, 2015a). Trucks have the advantage of being able to transport goods as soon as the trailer that they are transporting is loaded. Trains, however, need to wait for multiple loads or railcars to be loaded and connected before they can transport their load. Flexibility of transport methods has further been discussed in section 3.4.2.

This subsection (along with Section 3.4.6) answers the third research question mentioned in Section 3.1: "What are the main challenges that road-to-rail bimodal transport faces?".

### 3.4.6 Transport criteria/requirements

Freight owners and LSPs have certain criteria/requirements that they look for when considering different methods of transport. From analysing the sources, a few transport criteria/requirements became apparent:

- **Reliability:** The ability of the transporter to meet contractual agreements. This includes not being late and no damage to freight;

- **Speed or punctuality:** The time that it takes the freight to be transported and the accuracy of estimated times of arrival;
- **Frequency of services:** The frequency of trains that are available to transport freight (Example: one train a day);
- **Cost:** The cost per tonne-kilometre and the investment cost;
- **Flexibility:** The ability to adapt to a customer's needs (Černá, Zitrický, and Daniš, 2017);
- **Safety/security:** Number of accidents, loss of freight, and theft.

Nocera, Cavallaro, and Irranca Galati (2018), Černá, Zitrický, and Daniš (2017) and Roso, Brnjac, and Abramovic (2015b) all mention the importance of these criteria at least once. These requirements play a vital role in identifying companies that would be interested in using bimodal technology.

This subsection (along with Section 3.4.5) answers the third research question mentioned in Section 3.1: "What are the main challenges that road-to-rail bimodal transport faces?".

## 3.5 Key research paper: Methodology of selecting the transport modes

The paper discussed in this section (that ranked high in the relevance in the meta analysis) provides key information for the construction of the decision matrix in the preliminary toolkit.

The paper, written by Černá, Zitrický, and Daniš (2017), focuses on the selection of transport modes based on multiple criteria and factors. The authors of this paper write from the perspective of the landlocked country of Slovak Republic (Slovakia). This country has an extensive rail network and serves as a crossroad for freight flows in Europe. Much like South Africa the country has seen a large increase in road freight rather than rail freight in recent years.

The authors explain that there are numerous advantages and disadvantages to both road and rail. They propose using the following aspects of transport to measure the performance of different modes of transport.

**Price for transport** The cost of the transport of freight. This could be measured in cost per km or cost per tonne-km.

**Transport time** The time that it takes for the freight to be transported from origin to destination.

**Transport safety** The protection of goods against damage or loss. This can be measured in the number of accidents or by the amount of goods damaged.

**Reliability of carrier** The fulfilment of delivery times and contractual agreements.

**Information** The ability to obtain the location and any other relevant information of a load in real time.

**Flexibility** The ability to adapt to a customer's needs.

**Additional services** Any additional services offered by the LSP. This could include the loading/offloading of freight, weighing of the freight and the cleaning of wagons.

**Expertise and references** Expertise and good references from an LSP may help to increase the market share of the mode of transport that they use.

**Responsibility** Irresponsibility of the LSP may result in the loss of customers.

The last three aspects mentioned in the above list (additional services, expertise and references, and responsibility) are highly subjective and do not coincide with the most common transport criteria/requirements mentioned in the other sources referenced in this chapter. These aspects are therefore seen as having a lower level of commonality across the transport industry.

This paper suggests the use of a three-point weight system for the importance of the transport criteria. Customers can use these points to express their opinion on which criteria are more important. This system allows the customers to assign criteria with maximum importance a value of three and those of minimal importance a value of one. This scale also allows for the customer to have a neutral attitude toward certain criteria. This scale, however, has two flaws. First, the customer is unable to label a criterion as "not applicable", by for example assigning it a value of zero. Secondly, the scale does not provide the customer a wide range of values to express their opinion. A range of zero to five would therefore be more appropriate.

For rating the performance of a certain method of transport in a certain aspect this paper suggests the use of a binary scale of one and zero as described below:

**1:** Performs better than the other mode of transport.

**0:** Performs worse than the other mode of transport.

This scale is appropriate since the performance of a certain method of transport compared to another should not be subjective like the importance of transport criteria. One method of transport either outperforms the other, or it does not. This scale is especially useful since this paper focuses on only two modes of transport, namely, road and rail. For more than two modes of transport the following small adjustment to the descriptions could be considered:

**1:** Performs just as well as other systems with a value of 1.

**0:** Performs worse than other systems with a value of 1.

## 3.6 Chapter Conclusion

This chapter answered research questions that would provide the necessary information to be able to set up selection criteria for LSPs that would be able to use the RailRunner system. Answers to these questions were found in a way that is transparent and repeatable. This process includes gathering a wide range of sources that were filtered down to find relevant literature. A meta-analysis was then done to draw conclusions from patterns seen in the sources.

The information in this chapter is used to set up selection criteria for LSPs that would be able to use the RailRunner system. It also helps to set up a preliminary toolkit that LSPs will be able to use to assess the viability of using bimodal transport themselves. This chapter and Chapter 2 serve as an input to objectives 2 and 3 as seen in Sections 1.4.2 and 1.4.3 respectively.

# CHAPTER 4

# RailRunner system and technology

Contents

## 4.1 RailRunner company

RailRunner is a company that was started in North America and which, after extensive development, testing, and initial commercial operation, is now ready to implement their solution in North America, India, Egypt and recently South Africa.

In this thesis "RailRunner North America", is used to describe the parent company started in North America and "RailRunner South Africa", is used to describe the branch of the company based in South Africa. The term "RailRunner", is used when referring to the systems or technology that RailRunner implements regardless of the geographical area in which they operate.

## 4.2 Components and assembly

### Components

The technology that RailRunner implements is an example of a roadrailer. A roadrailer is defined as "a vehicle that can run on both road and rail" (*Oxford Dictionary* 2020). The RailRunner system involves the use of rail bogies and specialised truck trailers that link together to form train segments as seen in Figures 1.1, 1.2 and 1.3. These specialised truck trailers can be in the form of box trailers, curtain sides, tippers or almost any other conventional form of tri-axle truck trailer.

The following list explains the main differences between a conventional truck trailer and a RailRunner trailer:

- Currently, RailRunner South Africa trailers are a maximum of 13,65 metres long. RailRunner South Africa is currently approving the use of longer trailers. The length of trailers is limited due to the turning radius, as well as the vertical curves of hills and valleys, of the installed Cape gauge rail in South Africa;

- RailRunner trailers have a connector on both ends that allows the trailers to connect to the bogies;

- RailRunner trailers are strengthened to withstand the forces that they will experience while on rail. The trailers closest to the locomotive will have to withstand the tension and compression forces that the other trailers behind it impose on it when the train accelerates or decelerates;

- Lastly, an air pipe and electrical cables run through the trailers for the operation of the air brakes on the bogies.

The rail bogies and trailers that are used on the North American standard gauge (1 435 mm width) cannot fit on the narrower Cape gauge widely used in Southern Africa. The technology is therefore modified to adhere to the specifications of the Cape gauge. A cross-section and the measurement of rail gauge can be seen in Figure 4.1. The Cape Gauge has a width of 1 067 mm between the rails.

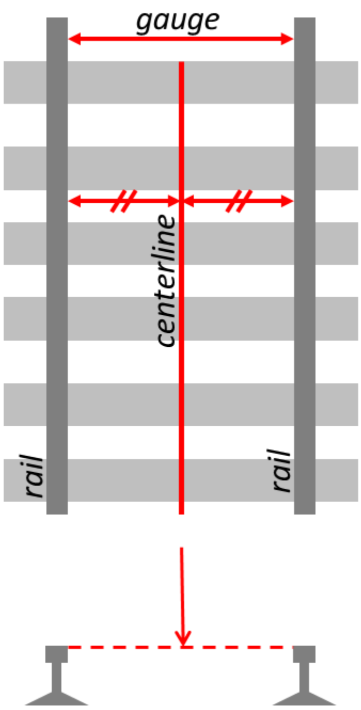


FIGURE 4.1: *Rail gauge (Elberink and Khoshelham, 2015)*

An example of a RailRunner bogie can be seen in Figure 4.2. This bogie contains the train wheels, air brakes and the suspension for the train when it is assembled.


FIGURE 4.2: *RailRunner bogie on rail (RailRunner, 2021a)*

The bogie has two connectors on each end that allow the RailRunner trailer to be attached and raised off the ground as seen in Figure 4.3. These facilitate the connection of the trailers to the bogies. A close-up shot of a RailRunner trailer sliding on to a bogie can be seen in Figure 4.4.


FIGURE 4.3: *RailRunner bogie connected to RailRunner trailers on rail (RailRunner, 2021a)*


FIGURE 4.4: *Close-up of a RailRunner trailer sliding onto a bogie (RailRunner, 2021a)*

Multiple RailRunner trailers and bogies can be connected to assemble a train. An example of this can be seen in Figure 4.5.

FIGURE 4.5: *RailRunner trailers connected to bogies on rail (RailRunner, 2021a)*

To connect the bogies to conventional rail wagons or a locomotive, a RailRunner transition bogie is used. This bogie has a connector for the RailRunner trailer on the one end and a standard rail wagon connector on the other end. A picture of this bogie can be seen in Figure 4.6. An example of a fully assembled RailRunner train including a locomotive can be seen in Figure 4.7.


FIGURE 4.6: *RailRunner transition bogie connected to a RailRunner trailer on rail (RailRunner, 2021a)*


FIGURE 4.7: *Assembled RailRunner train (RailRunner, 2021d)*

**Assembly of a RailRunner train**

The following steps and the accompanying Figure 4.8 demonstrate the process of assembling a RailRunner train.

1. A tractor positions a RailRunner trailer on the track and backs it onto a RailRunner bogie. As the trailer slides onto the bogie, the trailer's wheels lift off the track. Once the trailer is positioned on the bogie, a locking pin on the bogie automatically attaches the trailer to the bogie. The tractor then detaches from the trailer, leaving it on landing gear.

2. The tractor repeats step one for a second RailRunner trailer and bogie.

3. The tractor backs the entire second unit, consisting of the combined trailer and bogie, into the front of the first trailer. As the second bogie connects to the first trailer, the landing gear of the first trailer raises clear of the track. No manual raising of the landing gear is required.

4. The tractor disengages from the trailer and repeats the above process until the entire RailRunner train is ready for the locomotive.

5. The rail locomotive backs a RailRunner transition bogie into the assembled train. Air hoses are connected and airbags on all the RailRunner bogies are activated, further raising all the trailers on the train clear of the rail and cushioning the cargo. The train then departs from the terminal. (RailRunner, n.d.[a])

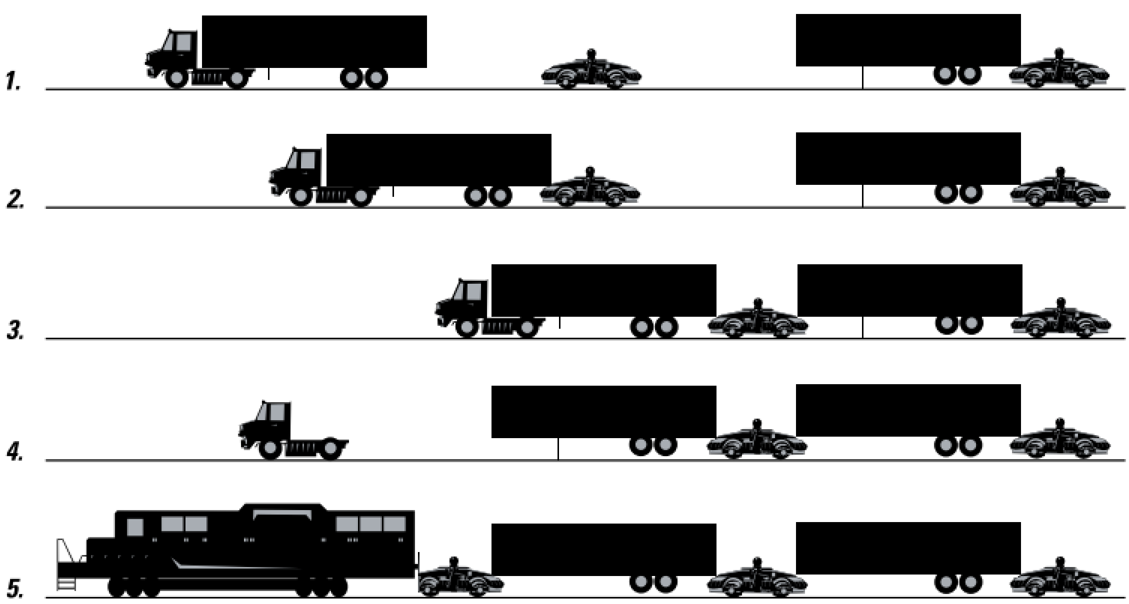


FIGURE 4.8: *RailRunner assembly (RailRunner, n.d.[a])*

## 4.3 Advantages over conventional bimodal road-to-rail systems

There are numerous advantages of the RailRunner bimodal solution over conventional bimodal solutions. First, traditional intermodal terminals are expensive to build and run. These terminals can cost as much as $50 - $100 million whereas a RailRunner terminal costs between $1 and $5 million (*Railways Africa* 2021). Less equipment is needed to set up a RailRunner terminal. Unlike conventional rail terminals, large cranes are not necessary for the movement of cargo. The only equipment that is needed to set up a terminal is as follows:

- A tractor or yard hostler to move trailers for assembly and disassembly of RailRunner trains;
- An air compressor capable of supplying 120 PSI of compressed air for the air suspension of the bogies;
- A forklift with 7 300 kg of lifting capacity for moving bogies on and off the track.

Furthermore, a truck driver and rail yard worker can easily assemble a train consisting of forty trailers in four hours. RailRunner states that many job opportunities will be created through the implementation of this system. According to RailRunner South Africa, 25-100 jobs can be created per thousand twenty-foot equivalent units (TEUs) that are moved through a terminal in a year. They estimate that this could translate to the creation of between 187 000 and 742 000 jobs in South Africa (RailRunner, 2021b).

Most of the transport being done on rail involves the use of shipping containers. Conventionally, large gantry cranes are needed to load and unload these containers from trains. With technology from RailRunner South Africa almost any type of truck trailer up to 13,65 metres in length can be transported via rail. This includes curtain side trailers, box trailers and flatbed trailers.

There are numerous other advantages of the RailRunner system:

- Airbag suspension and radial steering on the bogies lower noise and increase stability, reducing the risk of damage to freight;
- When the train is assembled, the doors of shipping containers being transported cannot be opened. This reduces the risk of theft (RailRunner, 2021f);
- When the RailRunner train is assembled, the space between the trailers/units is 0,7 meters compared to conventional systems where it is 3,3 metres. This allows for more trailers/units to be transported on the same length train. The smaller distance between containers also reduces the wind resistance of the train (RailRunner, 2021e).

## 4.4 Possible disadvantages of the RailRunner system

There are some possible disadvantages to using the RailRunner system compared to using traditional bimodal transport involving containers on flatcars COFC. This section discusses these disadvantages and how RailRunner South Africa intends to mitigate them.

### 4.4.1 Empty back-haul of trailers and bogies

#### Possible disadvantage

Multiple empty skeletal RailRunner trailers cannot be transported on rail. This is because the bogies need to carry a minimum amount of weight to travel safely on rail. If this minimum weight requirement is not met, then the bogies could potentially derail. Likewise, since bogies need to carry a certain amount of weight to be transported, there could also be a problem with the relocation of empty bogies.

#### Mitigation

One way to get around this problem is to place one empty skeletal trailer between two loaded trailers. This allows empty trailers to be transported while still meeting the minimum weight-bearing requirements of the bogies. A RailRunner train consisting of only empty skeletal trailers will therefore not be a viable configuration. RailRunner South Africa states that it would be preferable to sell the space on a trailer at a 50%—70% discount to relocate the trailer. It can then be used to transport a load at 100% of the going rate.

Empty skeletal RailRunner trailers could also be used for the repositioning of empty shipping containers on the Capecor and Natcor. This would be useful since there are major freight imbalances on these corridors (GAIN Group, 2020).

Another way to avoid this problem is to make use of a liquid bulk bladder as seen in Figure 4.9. The bladder could be filled with water and strapped onto a truck trailer to fulfil the minimum weight requirements when on rail. The bladder could be rolled up and stored in a box underneath the trailer when not in use. This also opens a possibility for bulk liquids (discussed in Section 4.7.4) to be transported in one direction while transporting palletised goods in another direction.

FIGURE 4.9: *Liquid bladder in truck trailer (Ancra New Zealand Ltd, 2021)*

The empty bogies could also be loaded onto empty skeletal trailers on the train. This would allow empty trailers and unused bogies to be transported at the same time without any chance of derailment due to weight requirements not being met.

It is important to note that only empty skeletal trailers cannot be transported on rail. Skeletal trailers carrying empty shipping containers and any other trailer configuration including curtain side, box, flatbed, tipper and reefer trailers, can safely be transported on rail even when empty.

### 4.4.2 Mechanical failure

#### Possible disadvantage

One cause for concern is the increased risk of failure of systems on the train if the equipment is not properly maintained. Some RailRunner trailers will be owned by logistics service providers (LSPs). If the LSPs do not maintain the trailers properly, the air pipes and electrical cables could become dysfunctional. This could cause a failure of the air brake systems on the bogies which would hinder the train's ability to slow down. This could cause the train to derail on sharp curves or collide with other trains or equipment. If a large-scale accident were to occur due to system failure, long-lasting negative conclusions could be associated with the technology causing LSPs to lose interest.

#### Mitigation

RailRunner South Africa states that all RailRunner trailers will have to go through an annual roadworthy and railworthy inspection. Similarly, RailRunner bogies will also need to go through a railworthy inspection annually. This would prevent the deterioration of equipment that could lead to a mechanical failure.

RailRunner South Africa states that half of the bogies' brakes in a train could fail, and it would still have enough braking power to operate safely. Furthermore, if the air suspension were to fail then one could easily replace the airbags with temporary spring suspension until the airbags can be replaced.

The trailers are also strengthened to such a degree that they can withstand the tension forces of 150 other trailers being pulled behind them while on rail. This shows that the trailers are strong enough to withstand the forces that they will experience in South Africa since a maximum of 50 trailers will be used in local trains. Furthermore, by using the brakes on the bogies, the trailers will also never experience excessive compressive forces of other trailers imposed on them while on rail.

If a mechanical failure were to happen, the train would be able to stop at a terminal or level crossing so that any compromised trailers could be removed. The train could then continue its journey. This, however, is extremely unlikely to happen given the rigorous certification processes that the trailers and bogies must go through to ensure safe use on rail.

### 4.4.3 Significant delays

#### Possible disadvantage

A concern that many LSPs or freight owners may have, is the possibility of significant delays on rail due to untrustworthy service from Transnet (South Africa's state-owned rail company). Transnet has a long history of questionable service and neglect of proper maintenance on infrastructure (Business Insider, 2021).

#### Mitigation

RailRunner South Africa states that, if a delay were to occur, and time-sensitive freight required immediate transport, they would be able to send a truck to the terminal where the train is waiting. The trailer could then easily be removed from the train and be transported the rest of the way to the destination via road without significant loss in transport time.

A network of truck owners would be established along the transport corridor to allow for fast response times in such situations. This would ensure that trucks are always available to transport RailRunner trailers if necessary. RailRunner would carry the cost of this service so that the freight owner would not be disadvantaged.

A "draw bar", of equal strength to that of a RailRunner trailer, could then be used to connect the two bogies together that were previously transporting the trailer. The train will then be able to travel the rest of the way to the destination terminal once the problem causing the delay has been cleared up.

This system could also be used at times when Transnet is doing maintenance on a section of the rail line. RailRunner South Africa would be able to set up temporary terminals on either side of the section that is undergoing maintenance and easily move the trailers via road from one terminal to the other.

### 4.4.4 Conversion of regular trailers into RailRunner trailers

#### Possible disadvantage

Regular trailers cannot be strengthened and converted into RailRunner trailers. RailRunner South Africa states that this process would be more costly than building a new RailRunner trailer from scratch and selling the old regular trailer.

#### Mitigation

A trade-in system could be used to allow users to trade in their regular trailer for a RailRunner trailer and to pay the difference in price.

### 4.4.5 Decreased carrying capacity

#### Possible disadvantage

As mentioned in Section 4.2, RailRunner trailers are strengthened to withstand the forces that they will experience while on rail. This adds extra material and weight to the trailer which in turn reduces the weight of the load that the trailer is legally allowed to carry on road. A RailRunner trailer is approximately 5 tonnes heavier than a conventional trailer.

#### Mitigation

This problem does limit the RailRunner South Africa's customer base to a small degree. RailRunner South Africa states that they will try to make the RailRunner trailers as lightweight as possible so that LSPs can carry heavier payloads. RailRunner South Africa states that they will still be able to provide their services to most of the market in South Africa given these weight limitations.

### 4.4.6 Possible negative economic effects

#### Disadvantage

One could argue that RailRunner South Africa would be taking away the jobs of truck drivers in South Africa. This could cause an uproar in the truck driver community. Furthermore, LSPs may argue that they would lose business because of this system being implemented.

#### Mitigation

RailRunner South Africa states that they would help truck drivers since they will be taking over the long-haul aspect of their job. They explain that truck drivers prefer short haul in their local area to long haul due to the risks involved such as accidents and hijackings experienced at night. There is also a shortage of long-haul truck drivers in South Africa. RailRunner South Africa hopes to alleviate this problem.

It must be mentioned that RailRunner South Africa does not aim to compete with LSPs in South Africa, but merely to empower them to move their freight on rail. One of the goals of

RailRunner South Africa is to lower the high logistics costs experienced in South Africa. This would make South African companies more competitive in domestic and international markets. The implementation of their solution could lower the price of imported goods and open up new business opportunities to companies in South Africa. RailRunner South Africa states that they could lower logistics costs by 20%-30% (*Railways Africa* 2021).

## 4.5 RailRunner in South Africa

In 2016 RailRunner South Africa signed a contract with Transnet Ltd (South Africa's state-owned rail transport company) to allow them to implement their bimodal solution on railway lines in South Africa. This is in line with Transnet's market demand strategy that involves the moving of traffic from South Africa's congested road highway network to rail (RailRunner, 2021c). Transnet's market demand strategy involves a R300 billion investment from the government and aims to modernise South Africa's ports, pipelines, and rail (Transnet, 2021). According to RailRunner South Africa's proposed business model, they will be managing the building, breaking, loading and delivering of the train while Transnet will only be doing the hook and haul of the train.

At the time of writing RailRunner was in discussions with investors to obtain funding to build prototype trailers and bogies with. They intend to build the prototypes in quarter three of 2022. They then plan to run a pilot project on the Capecor in Quarter one of 2023. Finlay, they plan to launch the service in quarter two of 2023.

### 4.5.1 RailRunner's plan for South Africa

RailRunner plans to implement their solution on the Capecor first, and then move on to other corridors like the Natcor and the North-South corridor running from Gauteng into the rest of Africa. On the Capecor they intend to have a set of two trains of 40-50 trailers leaving both Johannesburg and Cape Town every day. Another set of two trains will also be arriving at both Johannesburg and Cape Town every day. Lastly, there will be at least two trains on the rail track between the two locations every day. Therefore, six trains will either be arriving at, leaving from, or travelling between, Cape Town and Johannesburg every day.

The Natcor will operate similarly to the Capecor, but it will operate with one less set of trains since the travel time on this corridor is less. It must also be noted that another 40—50 trailers will be moving on road every day to collect/deliver freight around the different terminals. This applies to both corridors.

RailRunner South Africa hopes to one day be able to run trains that can travel from Cape Town to Johannesburg in less than a day (22 hours). The main problem with this is that there are three rail power systems on the route between Cape Town and Johannesburg. This results in the need for locomotives to be swapped from one power system to another along the route, causing significant increases in travel time. If Transnet were to run a regular scheduled service for RailRunner South Africa then they would have to find a way to improve the efficiency and reliability of switching locomotives.

For allocating space on a train, RailRunner South Africa intends to operate on an airline-based model where clients will pay different rates based on how quickly they would like to have their freight delivered. Trailers loaded with freight will be dropped off at terminals and will then be sent off with the next available train depending on the transport time agreed upon by the customer.

RailRunner also intends to implement their solution in the mining sector of which predominantly involves the transport of coal. For the scope of this thesis, however, the main focus will be on the Capecor and other transport corridors in South Africa.

### 4.5.2 Pilot project on the Capecor

The first use of the system in South Africa will be on the 1 400 km rail line between Cape Town and Gauteng. At the time of writing this thesis, RailRunner South Africa intends to run a pilot project involving a train with 20 trailers, 19 intermediate bogies and 2 transition bogies for each end. The pilot project will commence once the necessary staff have been trained and issued with RailRunner Operator certificates.

The following list accompanied by Figure 4.10, shows the process that will be followed by the pilot project. The information in this list is provided by RailRunner South Africa.

1. The RailRunner trailers are delivered to various clients in Gauteng and loaded with freight.
2. The trailers are transported by road to the RailRunner terminal at Isando.
3. A RailRunner train is assembled using the trailers and bogies.
4. The train is transported via rail, with a locomotive provided by Transnet, to Bellville in the Western Cape.
5. The train is disassembled at the terminal.
6. The trailers are transported by road to the clients' premises to be offloaded.
7. Once offloaded, the trailers are collected and transported to other clients in the Western Cape to be loaded with freight bound for Gauteng. The trailer could also be loaded by the same clients at the same location.
8. The trailers are transported by road to the RailRunner terminal in Bellville.
9. A RailRunner train is assembled using the trailers and bogies.
10. The train is transported via rail, with a locomotive provided by Transnet, to Gauteng.
11. The train is disassembled at the terminal.
12. The trailers are transported by road to the clients' premises to be offloaded.

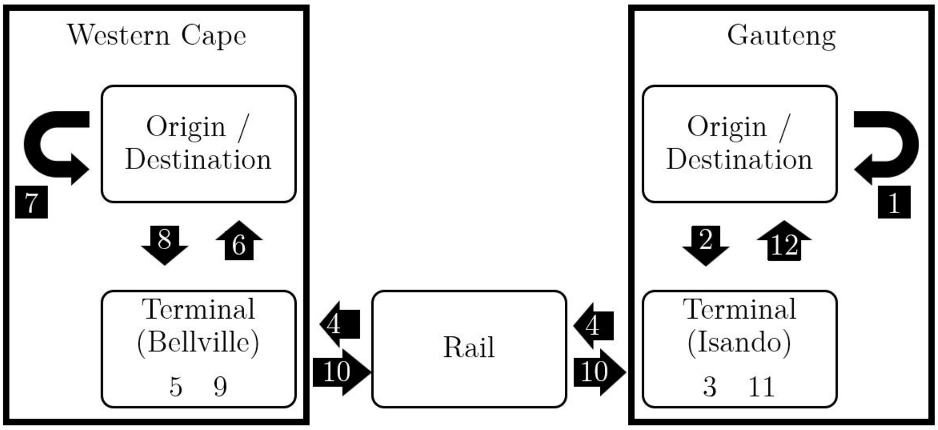


FIGURE 4.10: *RailRunner pilot process*

This process will be repeated for three to six months until RailRunner South Africa is certain that the system is working properly and safely.

### 4.5.3 Company structure

There are several companies involved in the use of the RailRunner system. Figure 4.11 shows the structure of these companies. RailRunner South Africa has a contract with Transnet to haul the RailRunner trailers. RailRunner South Africa also owns the RailRunner service company. The RailRunner Service Company will manage all terminal operations and serve as a service provider to LSPs. Lastly the LSPs are the service providers to the freight owners.

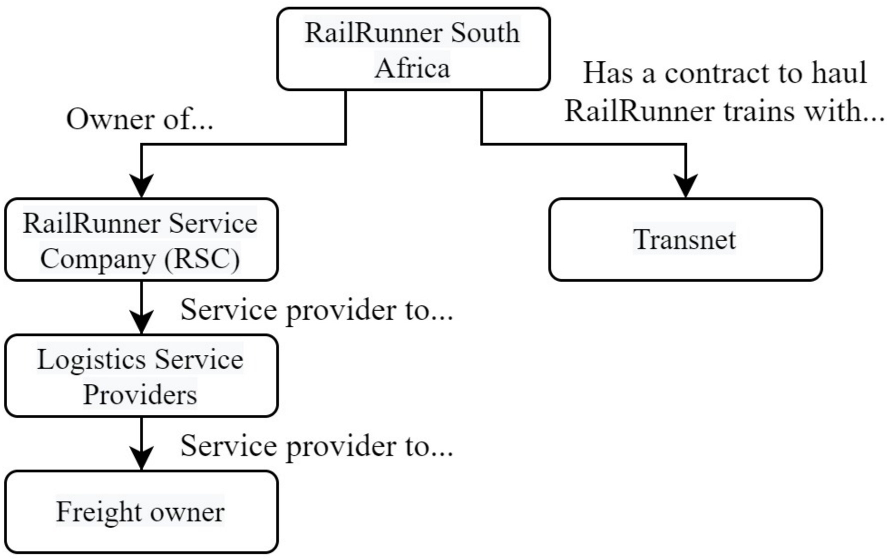


FIGURE 4.11: *RailRunner company structure*

## 4.6 RailRunner's Terminal Anywhere™ solution

RailRunner uses the trademarked term "Terminal Anywhere™". This represents their technology that can be used to set up terminals with low investment costs as well as low operational costs. RailRunner provides the necessary software for the management of the terminals. This includes the necessary information on maintenance and refurbishment, building and disassembling RailRunner trains, and the management of terminal logistics (RailRunner, 2021g).

The following infrastructure is needed to set up a RailRunner terminal:

- Rail siding that is 10% longer than the intended length of the train;
- Flat surface next to, and in-between the rail tracks that is level with the track. This is so that the trailers can be manoeuvred over the track to be connected to the bogies. This surface must be at least one trailer-width wide on each side of the track as demonstrated in Figure 1.2;
- Storage area for trailers waiting to be transported and unused bogies;
- Securely fenced terminal area with an office that has an internet connection;
- Software for managing daily operations.

This solution enables shippers to set up cost-effective terminals with low operational costs. Intermodal transport can therefore be made available to freight owners that are not located close to large established intermodal terminals. When freight volumes are inconsistent, LSPs may use more expensive road transport instead of rail. With the use of the Terminal Anywhere™ solution, a temporary terminal could be specially set up for when freight volumes are high. This is particularly useful for the transport of seasonal freight such as agriculture where freight volumes differ depending on the time of year (RailRunner, 2021g).

It must also be mentioned that terminals that see a high and consistent transport volume can also be set up. These terminals are large and permanently operational unlike the more temporary terminals that Terminal Anywhere™ technology makes possible. These terminals can handle the same volumes of freight as conventional bimodal terminals but at lower investment and operational costs.

## 4.7 Cargo types transported by RailRunner

This section discusses the different cargo types and the technology that RailRunner intends to use for the transport of those cargo types. Each subsection will focus on a different cargo type. The following cargo types are discussed:

- Agricultural dry bulk;
- Heavy break bulk;
- Light break bulk;
- Liquid bulk;
- Mining dry bulk;

- Palletised;
- Refrigerated;
- RO-RO (Roll On Roll Off);
- Open skip bulk.

Each cargo type requires a different type of trailer, as described in the subsections that follow.

### 4.7.1 Agricultural dry bulk

Agricultural dry bulk typically consists of grain and other dry commodities produced in the agricultural sector. See Figure 4.12. It is generally transported in open-top containers or tippers as seen in Figure 4.13. RailRunner can transport agricultural dry bulk by using a tipper trailer as seen in Figure 4.14.

FIGURE 4.12: *Typical example of agricultural dry bulk*

FIGURE 4.13: *Typical method of transport for agricultural dry bulk*

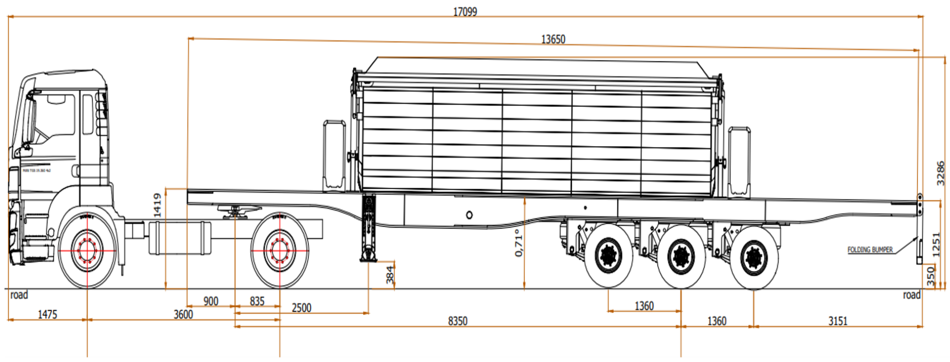


FIGURE 4.14: *Method of transport for agricultural dry bulk in the RailRunner system*

### 4.7.2 Heavy break bulk

Heavy break bulk is defined as bulk commodities that cannot be placed in an intermodal shipping container. An example is shown in Figure 4.15. It is generally transported on flatbed trailers as seen in Figure 4.16. RailRunner can transport it by using a similar trailer that is specialised for use in the RailRunner system.

FIGURE 4.15: *Typical example of heavy break bulk*

FIGURE 4.16: *Typical method of transport for heavy break bulk*

### 4.7.3 Light break bulk

Unlike heavy break bulk, light break bulk can be broken down into smaller components (such as those shown as an example in Figure 4.17). It can therefore be transported on a flatbed trailer (Figure 4.18) or in a shipping container (as in Figure 4.19 which shows a container on a flatbed RailRunner trailer).

FIGURE 4.17: *Typical example of light break bulk*

FIGURE 4.18: *Typical method of transport for light break bulk*

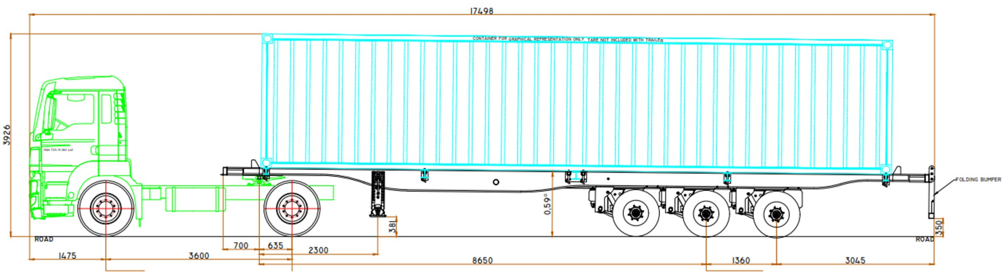


FIGURE 4.19: *Method of transport for light break bulk in the RailRunner system*

### 4.7.4 Liquid bulk

Liquid bulk (shown in storage tanks in Figure 4.20), is generally transported in tanker trailers as seen in Figure 4.21. In the RailRunner system, RailRunner trailers with similar tanks, or liquid bulk bladders strapped on to flatbed trailers could be used, as seen in Figure 4.22. Bladders can be rolled up and stored in a small compartment underneath the trailer. This would allow for other commodities to be transported on the trailer to avoid empty back-haul.

FIGURE 4.20: *Typical example of liquid bulk*


FIGURE 4.21: *Typical method of transport for liquid bulk*

FIGURE 4.22: *Method of transport for liquid bulk in the RailRunner system (Ancra New Zealand Ltd, 2021)*

### 4.7.5 Mining dry bulk

Similar to agricultural dry bulk, mining dry bulk (see Figure 4.23) is generally transported in open-top tipper vehicles as shown in Figure 4.24. RailRunner tipper trailers as seen in Figure 4.25 can be used to transport mining dry bulk .

Figure 4.23: *Typical example of mining dry bulk*

Figure 4.24: *Typical method of transport for mining dry bulk*

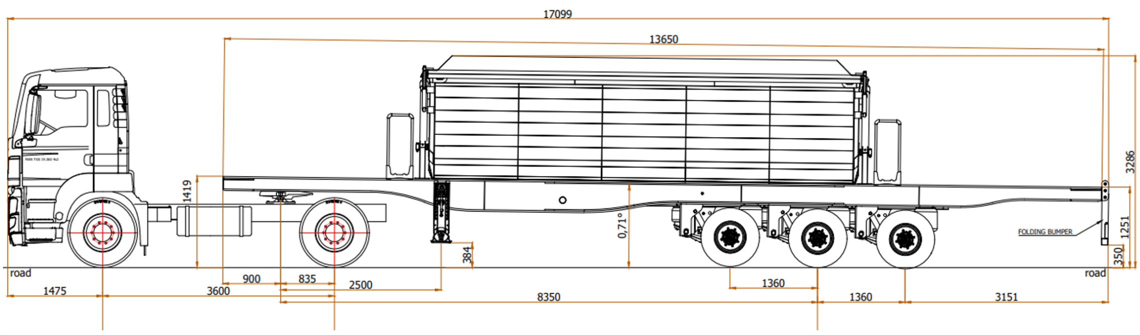


Figure 4.25: *Method of transport for mining dry bulk in the RailRunner system*

### 4.7.6 Palletised goods

Palatalised goods are goods that can be easily packaged and/or placed on pallets as seen in Figure 4.26. Box trailers/trucks (Figure 4.27) or curtain side trailers are used to transport these goods. An example of a RailRunner curtain side trailer can be seen in Figure 4.28.

FIGURE 4.26: *Typical example of Palletised goods*


FIGURE 4.27: *Typical method of transport for Palletised goods*

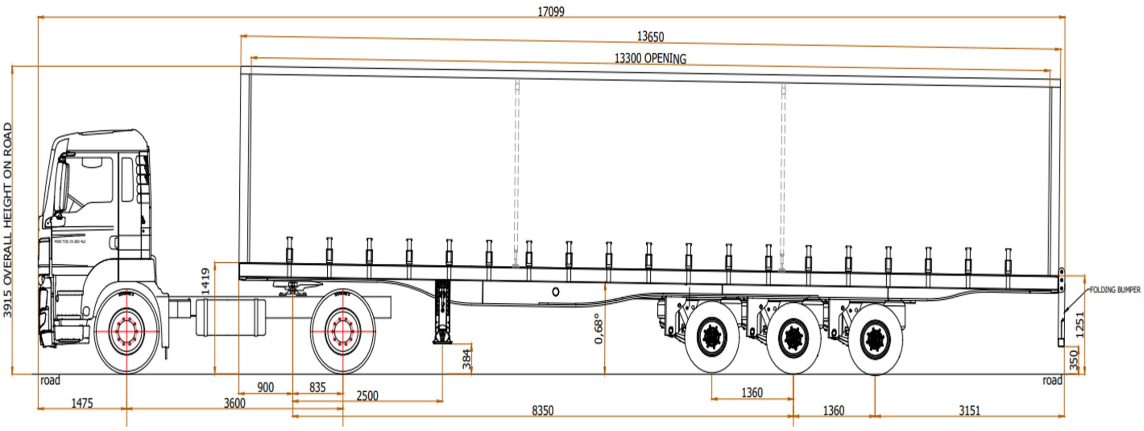


FIGURE 4.28: *Method of transport for Palletised goods in the RailRunner system*

### 4.7.7 Refrigerated goods

Refrigerated goods are goods that need to be kept at a low temperature, such as perishable foods (shown in Figure 4.29) or certain medical supplies such as vaccines. Vehicles with a refrigeration unit and insulated compartment (Figure 4.30), are used to transport these goods. An example of a RailRunner refrigerated trailer can be seen in Figure 4.31.

FIGURE 4.29: *Typical example of refrigerated goods*

FIGURE 4.30: *Typical method of transport for refrigerated goods*

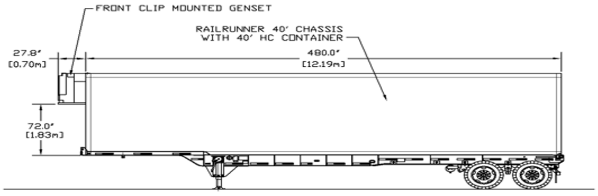


FIGURE 4.31: *Method of transport for refrigerated goods in the RailRunner system*

### 4.7.8 RO-RO

RO-RO (Roll On Roll Off) typically consists of cars and other small vehicles on wheels as seen in Figure 4.32. RO-RO is transported using specially modified trailers as seen in Figure 4.33. RailRunner will use a trailer that accommodates vehicles in a compact manner as seen in Figure 4.34. This trailer will also have a hard body that will protect the freight while on rail.

FIGURE 4.32: *Typical example of RO-RO*

FIGURE 4.33: *Typical method of transport for RO-RO*

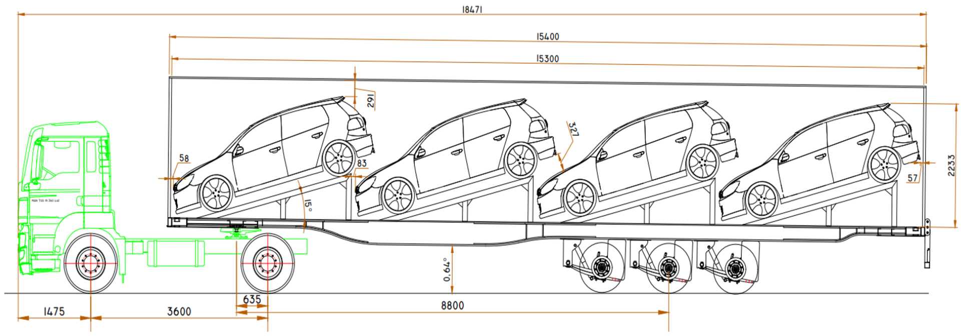


Figure 4.34: *Method of transport for RO-RO in the RailRunner system*

### 4.7.9 Open skip bulk

Open skip bulk involves skip containers, such as those shown in Figure 4.35 that can be easily loaded onto specialised truck beds as seen in Figure 4.36. RailRunner South Africa states that they do not plan to provide a solution for transporting this type of cargo.

Figure 4.35: *Typical example of open skip bulk*

Figure 4.36: *Typical method of transport for open skip bulk*

## 4.8 Conclusion

This chapter looked at the RailRunner company as well as the technology and systems that they implement. The following points were discussed:

- The components and assembly process of a RailRunner train;
- The advantages of the RailRunner solution compared to traditional container-on-railcar bimodal solutions;
- Possible disadvantages of the RailRunner system and how RailRunner intends to mitigate these disadvantages;
- RailRunner's presence and vision for operation in South Africa, including the initial pilot project;
- RailRunner's unique "Terminal Anywhere™", solution that enables them to set up terminals with low investment and operational costs;
- The different cargo types that RailRunner intends to transport and the technology they will use for those cargo types.

This chapter forms one of the inputs of the second research objective defined in Section 1.4.2. It helps to establish selection criteria for potential users of the RailRunner system.

# CHAPTER 5

# Defining selection criteria for potential users

Contents



## 5.1 Introduction

As discussed in Section 1.6, the information contained in Chapter 2, 3 and 4 is used to construct the selection criteria in this chapter. Chapter 2 explores the benefits and drawbacks of different types of bimodal transport systems. It also takes an in-depth look at the freight transport industry in South Africa and what constitutes viable bimodal transport. Chapter 3 looks at key topics such as road and rail characteristics, commodities transported on rail, bimodal challenges, and transport criteria/requirements. Lastly, Chapter 4 looks at the dynamics and specific characteristics of the RailRunner system and technology compared to conventional container on flat car (COFC) bimodal transport. Each of these three chapters provide information that is necessary to set up selection criteria for potential users of the RailRunner system. It must be reiterated that the potential users are the LSPs that will make use of the system. The selection criteria in this chapter can be grouped into the following two categories:

- Transport characteristics;
- Commodities / commodity characteristics;

It is difficult to construct selection criteria that provide definite answers to the suitability of the use of bimodal transport. Therefore, a five-point scale will be used to describe the importance of each criterion (with five being the most important). An adjective and definition are assigned by the author to each of these five levels of importance. This is done so that each criterion can be discussed using these adjectives instead of using ambiguous numbers. The levels of importance and their assigned adjectives and definitions are listed below:

- **5: Crucial**: Bimodal transport will not be viable if this criterion is not met;
- **4: Important**: A large influence on the viability of bimodal transport;
- **3: Preferable**: A notable influence on the viability of bimodal transport;
- **2: Relevant**: A small influence on the viability of bimodal transport;
- **1: Minimal**: Has minimal influence on the viability of bimodal transport.

It must also be noted that some criteria may be more important depending on what bimodal system is used. Most studies discussed in Chapter 2 and 3 on bimodal transport were on the use of containers of flat cars (COFC). However, RailRunner or roadrailer technology have differences that could influence the importance of certain criteria. This chapter therefore will take both COFC and roadrailers into account, and what criteria are more important for which.

## 5.2 Transport characteristics

This section discusses characteristics of freight transport and what constitutes the suitability of the use of bimodal technology. Each subsection discusses a different characteristic with references to discussions in previous sections in this thesis. These discussions are then used to construct a summary table at the end of the section. This is done so that specific transport criteria can be extracted form Chapters 2 to 4. The table is used in later sections to help identify LSPs that could benefit from the use of bimodal transport.

### 5.2.1 Transport distance

As discussed in Sections 2.10 and 3.4.1, a distance of 500km is needed for road-to-rail bimodal transport to be viable due to the increased cost of moving the freight between modes (Behrends, 2017) (Havenga, Z. P. Simpson, Fourie, et al., 2011). This is a crucial criterion for COFC. RailRunner may have a smaller viable distance due to their increased flexibility as mentioned in

Section 2.2.3, but insufficient research has been done to provide a comprehensive figure. Case studies could be done with specific LSPs to determine the exact distance at which bimodal transport would become viable.

### 5.2.2 Transport volumes

As discussed in Section 2.10, to justify the building of terminals and standardisation of processes, a minimum of 100 000 tonnes of freight needs to be transported per year (Havenga, Z. P. Simpson, Fourie, et al., 2011). This is equivalent to one round trip train per week as calculated in Table 5.1. It is roughly the amount that Transnet Freight Rail (South Africa's state-owned rail transport company) would like to be sure of to justify the construction of infrastructure and the purchase of locomotives. The current rail service requires a single user to have the required 100 000 tonnes. It is therefore crucial for the conventional COFC system to have these required volumes. The RailRunner system enables multiple LSPs to make use of the same locomotive. This allows for smaller volumes from multiple users to be combined to reach the threshold volume. This criterion is therefore only relevant the RailRunner system.

Table 5.1: *One way train transport volume per year*

| Variable | Value |
|---|---|
| Tonnes per trailer | 24 |
| Trailers per train | 40 |
| One-way trains per year | 52 |
| One-way train transport volume per year | 49 920 |
| Round trip train transport volume per year | 99 840 |

### 5.2.3 Transport routes

By looking at the freight flows in Section 2.6 one can see that most freight (excluding mining) flows along the Capecor and the Natcor (Havenga, Z. P. Simpson, King, D. de Bod, et al., 2016). The majority of operational rail and terminal infrastructure is also along these corridors. It is especially important for COFC to have this terminal infrastructure in place. It is therefore important for COFC to be used on these specific corridors. RailRunner however is not limited to transporting freight between large established terminals. They can construct cheap and efficient terminals wherever and whenever demand for transport is high (RailRunner, 2021g), as mentioned in Section 4.6. Some examples of this include the seasonal citrus transport from Tzaneen to Durban at one time of the year and the transport of grain out of the Free State province at other times of the year. Therefore, it would only be considered, in this study, as preferable for RailRunner to transport freight on the Capecor and Natcor because the RailRunner system is not as reliant on existing terminal infrastructure as the COFC system.

### 5.2.4 Origin and destination proximity to terminals

It is crucial for the origin and destination of freight moved using COFC to be close to rail terminals (González, Sánchez, and Romero, 2014) (as discussed in Sections 3.4.1 and 3.4.2). Like the criterion mentioned in Section 5.2.3, it would only be preferable for freight to be close to terminals if RailRunner is used since they can easily establish terminals (RailRunner, 2021g). This can be done wherever, and whenever there is sufficient demand. More research needs to be done to determine the exact distance that the origin and destination needs to be from rail terminals to justify bimodal transport.

### 5.2.5 Transport demand

The demand for transport needs to be stable and predictable (as stated in Section 2.9) (Vogt et al., 2005). This is because of the inflexibility of rail. Trains can only travel between established terminals on well-maintained rail lines. The fact that terminals cannot be easily constructed for COFC makes this criterion crucial for its viability but only preferable for RailRunner. This is because RailRunner terminals can be easily constructed as mentioned in Section 4.6. This would be done for seasonal freight such as agricultural crops.

### 5.2.6 Transport safety

Much like road transport, rail transport has various safety problems. These include risk of theft, breakage, and physical deterioration. As mentioned in section 2.9, safety has a major influence on the choice of mode of transport for LSPs. The safety of transport is considered to be even more important than the transport cost(Andersen, 1995). It is therefore crucial for both RailRunner and COFC transport to be safer than road transport.

It must be reiterated that RailRunner has certain safety benefits as mentioned in Section 4.3. When a train is assembled, the doors of shipping containers being transported cannot be opened. This reduces the risk of theft (RailRunner, 2021f). Furthermore, airbag suspension and radial steering on the bogies lower noise and increase stability, reducing the risk of damage to freight. These advantages may help RailRunner transport be safer than COFC transport, and possibly even safer than road transport.

### 5.2.7 Other costs

As mentioned in Section 2.9, rail needs to surpass, or rival road in certain aspects if rail is to be considered over road. These aspects include flexibility, service reliability, goods security, and total lead time. If rail performs poorly compared to road when it comes to these aspects, then costs other than transport rates could become a problem. These costs include high insurance cost, carrying cost for additional safety stock, and interest (incurred due to longer transport times on rail). These costs would negate the cost saved from lower transport rates. It is therefore crucial for both COFC and RailRunner methods to keep these costs as low as possible and outperform road in the aspects mentioned.

### 5.2.8 Freight packaging material/methods

Another factor that could negate the cost savings achieved with bimodal technology, is the need for expensive packaging material/methods. COFC requires the products to be placed in a shipping container to be shifted between road and rail. Extra protective material may also have to be used when freight is transported on rail. RailRunner technology will allow the freight to be transported with mostly the same packaging that would be used if it were to be transported on road. This criterion is therefore important for COFC and only relevant to RailRunner.

### 5.2.9 Transport time flexibility

As mentioned in Section 3.4.1, the use of rail would be attractive to companies that are flexible in terms of transport times (González, Sánchez, and Romero, 2014). This is because of the increased risk of delays due to the extra operations required to shift the freight between modes. Furthermore, the unreliability of the rail transport in South Africa brings its own set of time delay risks (Business Insider, 2021). Therefore, freight owners need to be flexible in terms of their transport time requirements. This is important for COFC but only preferable for the use of RailRunner, since the RailRunner system allows for a faster shift from road to rail. RailRunner can also remove a trailer from a train along its journey and move it to its destination quickly if a delay were to affect a time-sensitive load (Section 4.4.3).

### 5.2.10 Section summary

Table 5.2 provides a summary of the selection criteria discussed in this section. It is important to note that these aspects should be used in combination with each other. For example, a transport distance of more than 500km by itself does not constitute viable bimodal transport. The origin and destination of the freight would still need to be close to rail terminals.

TABLE 5.2: *Selection criteria for transport characteristics*

| | | | Importance | |
|---|---|---|---|---|
| ID | Criterion for viable bimodal transport | Section referenced | COFC | Roadrailer / RailRunner |
| A1 | Transport distance:<br>Greater than 500 km | 2.10<br>3.4.1 | Crucial | Important |
| A2 | Transport volume:<br>Greater than 100 000 tonnes per annum | 2.10<br>5.2.1 | Crucial | Important |
| A3 | Transport routes:<br>Capecor or Natcor | 2.6<br>4.6 | Important | Preferable |
| A4 | Origin and destination proximity to terminals:<br>Must be close (exact distance uncertain) | 3.4.1<br>3.4.2 | Crucial | Preferable |
| A5 | Transport demand:<br>Demand is stable and predictable | 2.9 | Crucial | Preferable |
| A6 | Transport safety:<br>No risk of theft, breakage, or physical deterioration | 2.9<br>4.3 | Crucial | Crucial |
| A7 | Other costs:<br>No high insurance or interest due to long lead times | 2.9 | Crucial | Crucial |
| A8 | Freight packaging material/methods:<br>No expensive packaging required | 2.9 | Important | Relevant |
| A9 | Transport time flexibility:<br>Must be flexible | 3.4.1 | Important | Preferable |

## 5.3 Commodities / commodity characteristics

As seen in Section 2.6, agriculture and manufacturing have considerable freight flow densities along the Capecor and Natcor. High freight flow densities, although necessary, do not necessarily determine the viability of bimodal transport. This section will discuss a few characteristics of commodities that are better suited for bimodal transport.

### 5.3.1 Raw materials

A trend explained in Section 2.11, shows that trains are more likely to transport raw materials as opposed to the final products that end users consume (Pienaar, 2007). This includes raw materials such as grain and steel, as opposed to breakfast cereal and kitchen appliances. Raw materials are generally less sensitive to time delays and unreliable transport. It is therefore preferable for COFC to transport this freight because of its low flexibility and longer transport time. RailRunner South Africa is aiming for a higher flexibility and shorter transport time which enables them to transport more finished and semi-finished goods. Therefore, it is only relevant to RailRunner that the freight is further from being processed into finished goods.

### 5.3.2 Goods that can be palletised

Havenga, Z. P. Simpson, Fourie, et al. (2011) states that to achieve standardisation of systems and increase transport density, it would be preferable for the freight being transported to be palletised (as discussed in Section 2.10). This is especially true for COFC because of the ease of packing and unpacking of shipping containers if freight is palletised. If the RailRunner system is used, then the truck trailers from part of the train. Therefore, the use of containers and pallets are not necessary, and less packing and unpacking of freight would have to be done. This criterion is therefore only relevant to RailRunner.

### 5.3.3 Preferable commodities

Trains are known to transport a wide range of commodities (discussed in Section 3.4.3). However, some commodities are better suited for rail. According to research done by Van Eeden and Havenga (2010), the following commodities would be best suited for bimodal transport in South Africa (discussed in Section 2.11):

- Processed foods;
- Beverages;
- Chemicals (other);
- Paper and paper products;
- Wood and wood products.

It is preferable for both COFC and RailRunner to transport these commodities since they can be palletised and have high volumes along the Capecor and Natcor.

### 5.3.4 Unwanted freight properties

Freight with certain properties that make it susceptible to unreliable transport, as discussed in Section 2.9, cannot be transported using COFC due to its inflexibility and increased transport time. The use of RailRunner mitigates these problems to a large degree, but it is still preferable to avoid the transport of freight with the following properties:

- Perishable;
- Subject to rapid ageing;
- Required on short notice;
- Is valuable in relation to its mass;
- Expensive to handle or store.

This criterion is therefore crucial for COFC but only preferable for RailRunner.

### 5.3.5 Cargo types that RailRunner can transport

As discussed in Section 4.7, RailRunner can transport certain cargo types. It is crucial for freight to fall under one of the following cargo types for RailRunner to be able to transport it:

- Agricultural dry bulk;
- Heavy break bulk;
- Light break bulk;
- Liquid bulk;
- Mining dry bulk;
- Palletised;
- Refrigerated;
- RO-RO (Roll On Roll Off);

The only cargo type that RailRunner is not able to transport is open skip dry bulk. It must also be noted that some of these cargo types may be easier to transport compared to others. However, further research is needed to be able to determine which.

### 5.3.6 Hazardous materials

One thing to consider is the transport of hazardous materials. Trains are considered as being the safer alternative to road transport (Bubbico, Di Cave, and Mazzarotta, 2004), (Rada, Ferronato, and Torretta, 2017) (as discussed in Section 3.4.1). It is therefore relevant to both COFC and RailRunner to consider the transport of hazardous materials. This would help to alleviate collateral damage to the general population in trucking accidents since train track routes tend to avoid populated areas.

### 5.3.7 Section summary

Table 5.3 provides a summary of the selection criteria discussed in this section. It outlines the commodities and properties of commodities that are best suited for the use of bimodal transport.

TABLE 5.3: *Selection criteria commodity characteristics summary*

| | | | Importance | |
|---|---|---|---|---|
| ID | Criterion for commodities potential users of bimodal transport | Section discussed | COFC | Roadrailer / RailRunner |
| B1 | Raw materials | 2.11 | Preferable | Relevant |
| B2 | Goods that can be palletised | 2.10<br>2.11 | Preferable | Relevant |
| B3 | Preferable commodities:<br>Possessed foods;<br>Beverages;<br>Chemicals (Other);<br>Paper and paper products;<br>Wood and wood products. | 2.11 | Preferable | Preferable |
| B4 | Unwanted freight properties:<br>Perishable;<br>Subject to rapid ageing;<br>Required on short notice;<br>Is valuable in relation to its mass;<br>Expensive to handle or store. | 2.9 | Crucial | Preferable |
| B5 | Falls under one of the following cargo types:<br>Agricultural dry bulk;<br>Heavy break bulk;<br>Light break bulk;<br>Liquid bulk;<br>Mining dry bulk;<br>Palletised;<br>Refrigerated;<br>RO-RO (Roll On Roll Off). | 4.7 | NA | Crucial |
| B6 | Hazardous materials. | 3.4.1 | Relevant | Relevant |

## 5.4 Chapter conclusion

As mentioned in Section 1.6, information from Chapters 2, 3 and 4, was used to establish the selection criteria for potential users of bimodal freight transport in this chapter. Note that the ”potential users”, are the LSPs as explained earlier. The following two main categories of selection criteria were established:

- Transport characteristics;

- Commodities / commodity characteristics;

The information in this chapter helped to establish a preliminary toolkit. Once the preliminary toolkit (as seen in Appendix B) was established, the next step was to conduct exploratory interviews. These interviews were used to add to and refine the preliminary toolkit.

# CHAPTER 6

# Exploratory interviews

Contents



## 6.1 Introduction

This chapter will look at the structure and the results of the exploratory interviews. The questions in these interviews were designed to add to, and refine the preliminary toolkit. The following list describes each element in the toolkit and the primary resource that was used to or will be used to develop it:

- A section explaining what the RailRunner system/technology is: Chapter 4;
- Selection criteria for LSPs that can benefit from the RailRunner system: Chapter 5;
- Stakeholder analysis on the role players that may have an interest or influence on the decision to use the RailRunner system: Exploratory interviews;
- A financial model comparing the operating costs of road-only systems with systems involving the RailRunner technology: Chapter 2 and exploratory interviews;
- Decision matrix that assists LSPs to quantify and visualise their attitudes towards different transport methods: Chapter 3 and exploratory interviews;
- A section on frequently asked questions that helps to clear up any misconceptions of the RailRunner system or technology: Exploratory interviews.

The full preliminary toolkit can be seen in Appendix B. This process continued until a finalised toolkit could be established. This was then used to conduct validation interviews. This process is demonstrated in Figure 6.1.

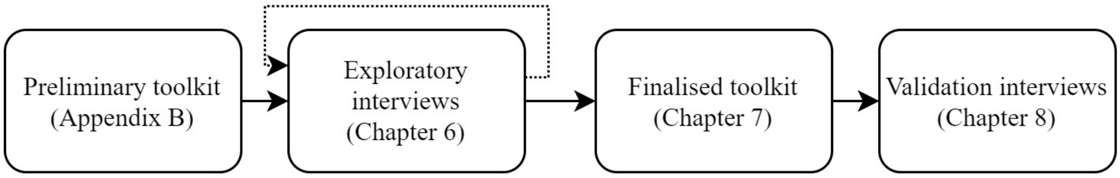


FIGURE 6.1: *Toolkit flow of completion*

This chapter aims to form part of the input to research objective four (finalised toolkit) as seen in Section 1.4.4.

## 6.2 Structure of the exploratory interviews

Each exploratory interview was made up of three elements; namely, an overview of a financial model, a questionnaire, and a decision matrix. The first interview included the financial model and decision matrix as seen in the preliminary toolkit in Appendixes B.5 and B.6 respectively. These elements were then added to, and modified, after each interview and used in future interviews. The process followed in each interview can be seen in Figure 6.2.

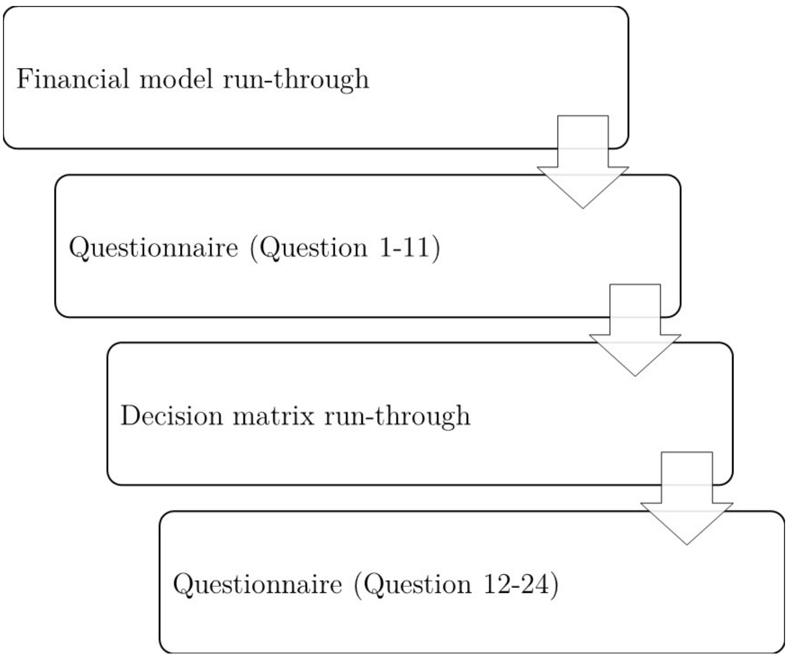


FIGURE 6.2: *Process of exploratory interviews*

The questions asked in the questionnaire can be seen in Table 6.1. Some question numbers in the table have an asterisk (*) next to them. These questions did not form part of the initial questionnaire and were added at later stages in the exploratory interview process. The aim of these interviews was not to validate the toolkit but to populate it with a wide range of data using a snowball approach. Therefore, it was not crucial for the interviewees that had already been interviewed to answer these questions.

TABLE 6.1: *Interview questionnaire*

| Question number | Question |
|---|---|
| 1 | What is your job title (or your relation to the institution that you are associated with)? |
| 2 | What is your area of expertise? |
| 3 | What commodities does the company that you associate with transport? |
| 4 | How do you transport these goods? |
| 4.1 | Road? |
| 4.2 | Rail? |
| 4.3 | Road and rail combination? |
| 4.4 | Air? |
| 4.5 | Sea? |
| 4.6 | Other? |
| 5 | How many trucks does your company own? |
| 6 | How many trucks does your company subcontract? |
| 7 | How many trucks does your company use in general? |
| 8* | What trailers do you use? (Flat-bed, curtain side, tippler etc.) |
| 9 | Where is your company based? Where do you operate and what routes do you take? |
| 10 | Who are potential stakeholders that would influence the choice of using road-to-rail technology? |
| 11 | On a scale of one to five (five being the most important), how important does the company you associate with find the following aspects of transport? Furthermore, how do you measure these aspects and what is important to you when considering these points? |
| 11.1 | Reliability? |
| 11.2 | Time/punctuality? |
| 11.3 | Frequency of services? |
| 11.4 | Cost of investment? |
| 11.5 | Cost per tonne-km? |
| 11.6 | Flexibility? |
| 11.7 | Safety/security? |
| 11.8 | Communication? |
| 11.9* | Environment? |
| 11.10* | Durability? |
| 11.11* | Political stability? |
| 11.12* | Financial stability? |
| 12 | What are the main challenges that you can see in using road-to-rail technology? |
| 13 | At what price reduction would you consider road-to-rail technology over road-only technology? |
| 14 | At what transit time increase would you still consider using it at this price reduction? |

| | |
|---|---|
| 15 | Do you think that road-to-rail technology is a viable option in the industry that you specialise in? |
| 16 | What do you like about the RailRunner system/technology? |
| 17 | What do you dislike about the RailRunner system/technology? |
| 18* | What could you see going wrong with the RailRunner system? (Possibly drawing from previous experiences) |
| 19 | What would you change on my financial model? |
| 20 | Do you think that your company will be willing and able to invest in the use of the RailRunner system? |
| 21 | If yes: how would you go about investing? Slowly replacing, how long until you do so etc.? |
| 22* | What other tools would you need to be able to make an investment decision? |
| 23 | Would you like to make any other comments? |
| 24 | Are there any questions in this questionnaire/interview that you would prefer not to be included in the final research paper? |

The questionnaire was used only to guide the interview. This was done so that any information that was not evident when first constructing the toolkit or interview structure could be explored. The interviewees could either be seen as associated with a particular business or just speaking as subject matter experts. Key information from each interview is discussed in Section 6.3.

One of the questions asked in the questionnaire was "On a scale of one to five (five being the most important), how important does the company that you associate with find the following aspects of transport?". The definitions of the levels of importance (as defined by the researcher) are as follows:

5: Critical

4: Important

3: Somewhat

2: Unimportant

1: Trivial

0: Irrelevant

These levels of importance will be used in the "weight" column of the decision matrix for each interviewee. Furthermore, the definitions (as defined by the researcher) of the aspects referred to in the question are as follows:

- **Reliability**: The ability of the LSP to meet contractual agreements;
- **Time/punctuality**: The time that it takes the freight to be transported and the accuracy of estimated times of arrival;
- **Frequency of services**: The frequency of services that are available (Example: one train a day);
- **Cost of investment**: The cost of investing in RailRunner trailers;

- **Cost per tonne-km**: The cost per tonne-km of the transport;
- **Flexibility**: The ability to adapt to the changing of a freight-owners' needs;
- **Safety/security**: Number of accidents, loss of freight, theft etc.;
- **Environment**: GHG emissions, fuel usage, noise pollution etc.;
- **Tracking (communication)**: The ability to track and communicate the location of freight to the freight owner;
- **Durability**: The longevity of the mode of transport. For example, a trailer will not last as long if it travels poorly maintained roads;
- **Political stability**: The political stability of the area that the transport is moving through. Political unrest could affect the profitability of freight transport;
- **Financial stability**: The financial stability of the regions that the freight originates from. This may be a concern for cross-border travel where exchange rates may affect the profitability of freight transport.

## 6.3 Exploratory interviews

This section contains discussions, results, and key information added to the finalised toolkit after each exploratory interview. Each subsection will contain the results of a different interview. The subsections will contain the following elements:

- **Interviewee description**: The background and summary of the interviewee being interviewed;
- **Financial model**: The comments, additions and modifications made to the financial model during the interview;
- **Decision matrix**: The decision matrix completed by the interviewee and the interpretation thereof;
- **Additions and modifications to interview structure**: The additions to the interview structure for future interviews;
- **Other toolkit additions and modifications**: Additions made to the preliminary toolkit after the interview is done;

To gain the largest amount of information from different areas of the transport industry, a wide range of subject matter experts with varying areas of expertise needed to be interviewed. Table 6.2 summarises the areas of expertise of people interviewed.

In accordance with ethical practices, no personal or sensitive information relating to the interviewees or the companies that they may be associated with, is disclosed in this thesis. This is to prevent the identification of any interviewees or companies involved in the research.

Table 6.2: *Interviewee descriptions*

| interviewee | Interviewee description |
|---|---|
| 1 | Managing director of a small LSP. |
| 2 | General manager of a large LSP. |
| 3 | Business development executive for LSP that operates in sub-Saharan Africa. |
| 4 | Subject matter expert associated with a freight owing company. |
| 5 | Consultant for a large LSP. |

### 6.3.1 Exploratory interview one: Managing director of small LSP

#### Interviewee description

This interview was done with the managing director a small LSP that owns and uses two trucks. The company is, however, part of a larger group and therefore has a greater number of resources and lower overheads than other small LSPs. The summary of this interviewee, and the business that they are associated with, can be seen in Table 6.3.

Table 6.3: *Interviewee description summary*

| | |
|---|---|
| Job title | Managing director/ Majority shareholder |
| Commodities transported | Machinery (forklifts, motorcycles, mining equipment), consumer goods (toys, retail), steel and general goods with a value under R1 million per load. |
| Mode used | Road/trucks |
| Number of trucks used | Two owned |
| Based in | Gauteng |
| Operates on | Natcor |
| Speaking | On behalf of the company that they are associated with. |

#### Financial model

The interviewee pointed out that toll fees should be added to the financial model as it is an important cost for long-distance road transport. Toll fees would not be applicable to rail since these are covered by the fee that RailRunner must pay Transnet to haul the trailers. An extract from the financial model showing the toll fees for a trip on the Capecor can be seen in Table 6.4.

TABLE 6.4: *Toll fees addition to financial model*

| Transport methods | DC to DC (Superlink) | DC to DC (Tri-axle) | Catching your own pass | DC to Terminal (2 PMs in system) |
|---|---|---|---|---|
| Toll fees per trip | R 826 | R 826 | R 826 | NA |

### Decision matrix

The decision matrix, as seen in Table 6.5, was constructed using the values for the levels of importance acquired from the answers to questions 11.1—11.8. These values were used for the weights in the decision matrix. The ones and zeroes seen in the matrix represent the following opinions/perspectives of the interviewee:

1: Performs just as well as other systems with a value of 1.

0: Performs worse than other systems with a value of 1.

TABLE 6.5: *Decision matrix*

| | | | Transport methods | | | |
|---|---|---|---|---|---|---|
| | | Weight | DC-to-DC superlink | DC-to-DC 6 axle artic | Catching your own pass | DC-to-Terminal |
| Aspects of transport | Reliability | 5 | 1 | 1 | 0 | 0 |
| | Time/punctuality | 4 | 1 | 1 | 0 | 0 |
| | Frequency of services | 3 | 1 | 1 | 1 | 1 |
| | Cost (Investment) | 3 | 1 | 0 | 1 | 0 |
| | Cost (tonne-km) | 4 | 0 | 0 | 0 | 1 |
| | Flexibility | 1 | 1 | 1 | 0 | 0 |
| | Safety/security | 5 | 0 | 0 | 1 | 1 |
| | Tracking (communication) | 4 | 1 | 1 | 1 | 1 |
| | Total | 29 | 6 | 5 | 4 | 4 |
| | Weighted total | | 20 | 17 | 15 | 16 |

It must be reiterated that the weight values and the performance values of each transport method are the perception and opinion of the interviewee. The weighted total is intended to accurately depict the view of the interviewee on the overall performance of each transport method. The following discussion will look at what the interviewee said in the interview. If the views expressed by the interviewee are in line with the outcome of the decision matrix, then one could say that the weighted total accurately represents the view of the interviewee .

When asked about the problems that the interviewee may see in the use of the RailRunner system, they stated that the main issue is that it relies heavily on the ability of Transnet (South Africa's state-owned rail company) to be able to provide a reliable service. They also stated that because of this they would rather want to see the success of the RailRunner system before they decide to invest.

The interviewee also said the following about the different aspects of freight transport:

- **Time/punctuality**: Time/punctuality is important but not critical. This is because freight owners in South Africa are generally quite tolerant of delays and understand that problems may occur during transport. One must just keep the freight owner informed on the status of their freight.
- **Cost (Investment)**: The investment cost is only somewhat important. The capital needed would not be as much of a problem as the cash-flow implications of making an investment would be.
- **Cost (Transport)**: The reliability is more important than the cost of transport. They would rather take less profit and have a greater reliability so that the freight owners can remain satisfied.

**Safety/security**: Safety is critical to this interviewee. They state that theft is a major problem for them and that they pay a large amount of money for insurance as a result. They expressed that the RailRunner system would help in terms of reducing breakdowns and reducing theft seen in road transport.

When asked to fill in the decision matrix, this interviewee considered the transport methods involving road to outperform the methods involving rail in the aspects of reliability and time/punctuality. Furthermore, the interviewee also regarded these aspects to have a high level of importance. This is in line with the information provided by the interviewee above. These aspects therefore have the greatest influence on the fact that the interviewee has a negative view of the use of rail in South Africa. It can therefore be concluded that if the perceptions of these aspects could be changed to be in favour of the transport methods using RailRunner then the interviewee may consider the RailRunner system to outperform road transport overall.

It is safe to say that the decision matrix accurately depicted the view of the interviewee. They were generally positive toward the use of the RailRunner system, but they were put off by the possibility of poor reliability and punctuality. The weighted total of the decision matrix reflects this with the DC-to-terminal transport method scoring only slightly lower than the DC-to-DC superlink method.

The information in the discussion above was used to write recommendations for the weight values in the finalised toolkit.

#### Additions and modifications to interview structure

Questions 8, 11.9 and 18 (as seen in Table 6.1) were added to the questionnaire after this interview was conducted. Question 8 ("What trailers do you use (Flat-bed, curtain side, tippler etc.)?") was added due to the interview leading to the topic of what truck trailers are used for what applications. It became apparent that what trailers are used is an important aspect of using RailRunner technology. The trailers used determine the ability to transport the cargo types as outlined in selection criterion B3 seen in Section 5.3.

Question 11.9 ("How important does the company you associate with find the environmental aspect of transport?") was added after the interviewee pointed out that the environment is becoming an important consideration in the freight transport industry. They stated that it is something that they consider when deciding on modes of transport used.

They also described a situation in which an entire truck trailer was stolen on the Natcor. The description of this incident contained a lot of detail on the different things that could go wrong while transporting freight. Question 18 ("What could you see going wrong with the RailRunner system (Possibly drawing from previous experiences)?") was therefore added because of the potential information that could be gained from previous experiences of future interviewees.

#### Other toolkit additions and modifications

The interviewee said that they would be the decision maker on whether to use the RailRunner technology since they are the managing director and majority shareholder in the company. The roles of managing director and majority shareholder were therefore added to the list of key player stakeholders.

As mentioned in the previous section, the aspect of environmental impact was added to the decision matrix in the toolkit. This is an aspect that is becoming an increasingly important consideration in the freight transport industry.

The transport cost reduction at which the interviewee said that they would consider the use of the RailRunner system is 10%. However, they stated that a larger LSP may consider a smaller percentage due to the smaller profit margins and the larger number of trucks used. This information was included in the recommendations of the decision matrix in the finalised toolkit in Section 7.7.2.

### 6.3.2 Exploratory interview two: General manager of large LSP

#### Interviewee description

This interview was done with the general manager of a large LSP that makes use of over 100 trucks. A summary of this interviewee can be seen in Table 6.6.

TABLE 6.6: *Interviewee description summary*

| | |
|---|---|
| Job title | General manager |
| Commodities transported | A wide range of commodities including agricultural products like grain and fertilizer, coal, containers (on Natcor), Fast-moving Consumer Goods (FMCG) and steel. |
| Mode used | Road/trucks. |
| Number of trucks used | > 80 owned and > 200 subcontracted. |
| Based in | Stellenbosch. |
| Operates in | Mostly in South Africa and in the Southern African Development Community |
| Speaking | On behalf of the company that they are associated with. |
| Types of trailers used | Superlink trailers: taut-liners, flat-beds, tippers, low beds.<br>Tri-axle trailers: flat-beds. |

**Financial model**

The interviewee pointed out that the lower wages may be applicable to the DC-to-terminal method. This is because it involves shorter transport distances. Truck drivers that operate on longer routes receive higher pay because they often do not get to sleep at home and are exposed to dangers such as accidents and theft. The interviewee suggested a value of R22 000 per month should be paid to these drivers, as opposed to the R28 000 suggested by Braun (2019). This would amount to R44 000 in the financial model due to the involvement of two drivers in the DC-to-terminal method. Examples of these values can be seen in an extract from the financial model in Table 6.7.

TABLE 6.7: *Suggested driver wages for the DC-to-terminal*

| Transport methods | DC to DC (Superlink) | DC to DC (Tri-axle) | Catching your own pass | DC to Terminal (2 PMs in system) |
|---|---|---|---|---|
| Driver Wages Per Month | R 28 000 | R 28 000 | R 28 000 | R 44 000 |

They also mentioned that lower fuel economy may be applicable to transport methods involving shorter transport legs such as the DC-to-terminal transport method. Trucks use less fuel when on the highway compared to driving on city streets. The suggestions they made can be seen in Table 6.8.

Lastly, the interviewee mentioned that a superlink trailer could transport between 34 and 36 tonnes while a tri-axle trailer could transport around 28 tonnes. They also explained that the Cost Per Kilometre (CPK) should be around R15 per km for a 7-axle superlink vehicle. This is in contrast to the values seen in Table 2.5.

TABLE 6.8: *Suggested fuel usage in financial model*

| Transport method | DC to DC (super link) | DC to DC (tri-axle) | Catching your own pass | DC to Terminal (2 primary movers) |
|---|---|---|---|---|
| km/litre (primary mover) | 2,20 | 2,20 | 2,20 | 2,20 |

### Decision matrix

The decision matrices as seen in Tables 6.9 and 6.10 were constructed using the values for the levels of importance acquired from the answers to questions 11.1—11.9. These values were used in the "weights", column of the decision matrix. The interviewee explained that the weights varied depending on what commodities were being transported. The interviewee mentioned two main commodity types, namely Fast-moving Consumer Goods (FMCG) and dry bulk. The ones and zeroes seen in the matrix represent the following opinions/perspectives of the interviewee:

1: Performs just as well as other systems with a value of 1.

0: Performs worse than other systems with a value of 1.

The interviewee pointed out that transport time, frequency of services, flexibility and communication are a lot more important for FMCG than they are for dry bulk. This is because FMCG are more sensitive to changes in lead time. This also causes FMCG to have a greater need for communication between the LSP and the freight owner so that any delays can be communicated if they occur. These differences in the importance/weights of the aspects of transport for FMCG and dry bulk are summarised in Table 6.11.

TABLE 6.11: *Difference in importance/weight for FMCG and dry bulk*

| | Weights for FMCG | Weights for dry bulk |
|---|---|---|
| Time/punctuality | 4 | 2 |
| Frequency of services | 5 | 2 |
| Flexibility | 5 | 3 |
| Tracking (communication) | 5 | 3 |

When asked about what the interviewee dislikes about the RailRunner system, they pointed out the questionable reliability of Transnet. They stated that not only is the transport between terminals unreliable, but also the operations within the terminals. It is a common occurrence, according to them, that the train needs to wait a day or two after arriving in the terminal to be unloaded. Therefore, they said that three days to travel the length of the Capecor on rail

TABLE 6.9: *Decision matrix for FMCG*

| | FMCG | Weight | DC-to-DC superlink | DC-to-DC 6 axle artic | Catching your own pass | DC-to-Terminal |
|---|---|---|---|---|---|---|
| | | | Transport methods | | | |
| Aspects of transport | Reliability | 5 | 1 | 1 | 0 | 0 |
| | Time/punctuality | 4 | 1 | 1 | 0 | 0 |
| | Frequency of services | 5 | 1 | 1 | 0 | 0 |
| | Cost (Investment) | 2 | 1 | 1 | 0 | 0 |
| | Cost (tonne-km ) | 5 | 0 | 0 | 1 | 1 |
| | Flexibility | 5 | 1 | 1 | 0 | 0 |
| | Safety/security | 4 | 0 | 0 | 0 | 0 |
| | Environment | 3 | 0 | 0 | 1 | 1 |
| | Tracking (communication) | 5 | 1 | 1 | 1 | 1 |
| | Total | 38 | 6 | 6 | 3 | 3 |
| | Weighted total | | 26 | 26 | 13 | 13 |

TABLE 6.10: *Decision matrix for dry bulk*

| | Dry bulk | Weight | Transport methods: DC-to-DC superlink | DC-to-DC 6 axle artic | Catching your own pass | DC-to-Terminal |
|---|---|---|---|---|---|---|
| Aspects of transport | Reliability | 5 | 1 | 1 | 0 | 0 |
| | Time/punctuality | 2 | 1 | 1 | 0 | 0 |
| | Frequency of services | 2 | 1 | 1 | 0 | 0 |
| | Cost (Investment) | 2 | 1 | 1 | 0 | 0 |
| | Cost (tonne-km ) | 5 | 0 | 0 | 1 | 1 |
| | Flexibility | 3 | 1 | 1 | 0 | 0 |
| | Safety/security | 4 | 0 | 0 | 0 | 0 |
| | Environment | 3 | 0 | 0 | 1 | 1 |
| | Tracking (communication) | 3 | 1 | 1 | 1 | 1 |
| | Total | 29 | 6 | 6 | 3 | 3 |
| | Weighted total | | 17 | 17 | 11 | 11 |

is unrealistic. Furthermore, they stated their concern for the theft of freight at the terminals. They said that inside jobs at Transnet are mostly responsible for this theft. They stated that the use of the RailRunner system may alleviate these problems to a certain degree.

They stated that the system has a better chance of working for dry bulk commodities rather than, for example, refrigerated goods because of the unreliability of rail. They further expressed their doubts in RailRunner by stating that they would have to invest in the RailRunner trailers and look for customers to use the RailRunner system without any assurance of success.

Given the views of the interviewee seen above, one can see why they thought that the transport methods involving road outperformed those involving rail in most aspects. The fact that the interviewee was generally negative towards the use of rail, especially for the transport of FMCG, clearly showed in the weighted totals of the decision matrices. This shows that the decision matrices accurately depicted the attitude of the interviewee towards the use of the RailRunner system.

#### Additions and modifications to interview structure

No new or unforeseen topics were discussed in this interview therefore no additions or modifications were made to the structure of the interview.

#### Other toolkit additions and modifications

The interviewee stated that as the general manager, they would be responsible keeping the investors of the company satisfied. They stated that the investors would have a low level of interest but a high level of power in the decision to use the RailRunner system. Therefore, the role of general manager was added to the list of key players and the role of investors was added to the list of people that need to be kept satisfied in the stakeholder analysis in the finalised toolkit in Chapter 7.

A question that the interviewee had, was "How do refrigerated trailers get power?". The answer to this is that, if necessary, the RailRunner trailers will have an underslung diesel generator and fuel tank capable of six days' uninterrupted cold chain. This generator would be able to supply power whether the trailer is on road or rail. An example of a trailer with an underslung generator can be seen in Figure 6.3.


FIGURE 6.3: *Example of a reefer container on a RailRunner trailer with an underslung diesel generator*

### 6.3.3 Exploratory interview three: Business development executive

#### Interviewee description

This interviewee spoke as a subject matter expert in the transport industry. They work as a business development executive for Africa in a large LSP. Their focus is on road and developing transport solutions in Africa. Table 6.12 shows a summary of the interviewee description.

TABLE 6.12: *Interviewee description summary*

| | |
|---|---|
| Job title | Business development executive for Africa. |
| Speaking | As a subject matter expert in the transport industry. |
| Commodities transported | Almost all commodities. This includes consumables, equipment, mining, agriculture, automotive, healthcare, etc. |
| Mode used | Road, rail, road and rail combination, air, and sea. |
| Number of trucks used | $>$ 5 000 owned and $>$ 16 000 subcontracted. |
| Based in | Johannesburg. |
| Operates in | African continent. |
| Types of trailers used | All forms of widely available trailers. |

#### Financial model

The interviewee stated that the catching-your-own-pass transport method may not be a practical solution. They say that the system could cause the truck(s) involved to wait for loads because of the precise planning and timing required. This would cause a loss of time and money. Their proposed solution is to rather subcontract any trucks that are available to do the short haul segments. This would reduce the time spent by trucks waiting for a load.

The interviewee stated that the kilometres per annum should be >210 000 km. This would result in a 5,5 day work week (286 work days a year) with an average trip time of two days on the Capecor. They also stated that the CPK should be between R14 and R16 per km. They said that the fixed costs cannot be changed, so the savings would have to be gained by increasing the kilometres driven. The values used can be seen in an extract from the financial model in Table 6.13.

TABLE 6.13: *CPK in the financial model*

| Transport methods | DC to DC (Superlink) | DC to DC (Tri-axle) | Catching your own pass | DC to Terminal (2 PMs in system) |
|---|---|---|---|---|
| Days to make one trip | 2,0 | 2,0 | 3,0 | 3,0 |
| Working Days | 286 | 286 | 286 | 286 |
| Truncated content | | | | |
| **KMPA (Primary Mover)** | **221 650** | **221 650** | **182 087** | **137 280** |
| Truncated content | | | | |
| **Total CPK (Rands/Km)** | **R 16,02** | **R 15,76** | NA | NA |

They also mentioned that the price of trucks could be about R1,3 to R1,5 million after negotiation if multiple trucks were to be bought at once. This would apply to large companies that have the necessary capital to invest in many trucks. The same logic applies to the trailers. The suggested costs can be seen in an extract form the financial model in Table 6.14.

TABLE 6.14: *Cost of primary movers in the financial model*

| Transport methods | DC to DC (Superlink) | DC to DC (Tri-axle) | Catching your own pass | DC to Terminal (2 PMs in system) |
|---|---|---|---|---|
| Prime Mover | R 1 500 000 | R 1 500 000 | R 1 500 000 | R 3 000 000 |
| Regular Trailer | R 500 000 | R 400 000 | R 400 000 | NA |

The fuel usage was also said to be around 2,2 km/litre in South Africa due to factors like the types of trucks and quality of fuel used. This information and all the other information in this section was included in the finalised toolkit.

### Decision matrix

The decision matrix as seen in Table 6.15 was constructed using the values for the levels of importance acquired from the answers to questions 11.1—11.12. These values were used as weights in the decision matrix. The ones and zeroes seen in the matrix represent the following opinions/perspectives of the interviewee:

1: Performs just as well as other systems with a value of 1.

0: Performs worse than other systems with a value of 1.

TABLE 6.15: *Decision matrix*

| | | | Transport methods | | | |
|---|---|---|---|---|---|---|
| | | Weight | DC-to-DC superlink | DC-to-DC 6 axle artic | Catching your own pass | DC-to-Terminal |
| Aspects of transport | Reliability | 5 | 1 | 1 | 0 | 0 |
| | Time/punctuality | 5 | 1 | 1 | 0 | 0 |
| | Frequency of services | 5 | 1 | 1 | 0 | 0 |
| | Cost (Investment) | 4 | 1 | 1 | 0 | 0 |
| | Cost (tonne-km ) | 4 | 0 | 0 | 1 | 1 |
| | Flexibility | 4 | 1 | 1 | 0 | 0 |
| | Safety/security | 5 | 1 | 1 | 0 | 0 |
| | Environment | 5 | 0 | 0 | 1 | 1 |
| | Tracking (communication) | 5 | 0 | 0 | 1 | 1 |
| | Durability | 3 | 0 | 0 | 1 | 1 |
| | Political stability | 3 | 1 | 1 | 0 | 0 |
| | Financial stability | 3 | 1 | 1 | 0 | 0 |
| | Total | 51 | 8 | 8 | 4 | 4 |
| | Weighted total | | 34 | 34 | 17 | 17 |

This interviewee's experience in the transport industry in Africa prompted them to suggest three additions to the aspects of transport as described in the following list:

- **Durability**: This is the longevity of the mode of transport. For example, a trailer will not last as long if it travels on poorly maintained roads;
- **Political stability**: This is the political stability of the area that the transport is moving through. Political unrest such as policy changes or war could affect freight transport through a country;
- **Financial stability**: This is the financial stability of the regions that the freight originates from. This may be a concern for cross-border travel where exchange rates may affect the profitability of freight transport.

These three aspects may not be applicable to freight on the Capecor or Natcor since these corridors do not travel across borders and have well-maintained roads. The aspects were, however, added to the finalised toolkit for the LSPs that may travel across borders or over rough terrain.

The interviewee pointed out that any investment in rail transport is difficult to back out of. Therefore, investments involving rail would be risky in politically and financially unstable countries. They did, however, state that the RailRunner trailers would last longer than regular trailers due to the reduced time spent on road. This is because trailers tend to deteriorate quickly when travelling over rough terrain as opposed to travelling on rail.

The interviewee expressed their doubts about the three days' time for a load to be transported on the Capecor via rail. This is once again due to the unreliability of Transnet. They stated that if you take the cost of capital of the freight into account, then delays could easily result in big losses for the freight owners. They also expressed their concern for theft on rail. They said that theft is a big concern for rail, and it adds a considerable amount of risk.

They also stated that the cost of investment would eventually turn in the favour of the systems involving RailRunner technology once the trailers are paid off since they last longer than regular trailers. If the transport methods involving RailRunner technology were to outperform the methods involving road then the weighted total would reduce to 30 for the DC-to-DC systems and increase to 21 for the systems involving RailRunner technology.

The interviewee stated that they would look at all the aspects of transport and not just the transport cost when considering the use of RailRunner technology. Following on from this, they said that they think that rail is a viable option but not in South Africa. Given the information above, one can clearly see that the weighted total of the decision matrix accurately depicts the negative attitude of the interviewee toward the use of the RailRunner system.

### Additions and modifications to interview structure

Due to the background and experience of the interviewee in working in other African countries, the following three aspects of transport were added to the question of "How important does the company you associate with find the following aspects of transport?":

> 11.10: **Durability**: The longevity of the mode of transport. For example, a trailer will not last as long if it travels on poorly maintained roads;
>
> 11.11: **Political stability**: The political stability of the area that the transport is moving through. Political unrest could affect the profitability of freight transport;
>
> 11.12: **Financial stability**: The financial stability of the regions that the freight originates from. This may be a concern for cross-border travel where exchange rates may affect the profitability of freight transport.

Furthermore, to start the process of completing the finalised toolkit, Question 22 was added ("What other tools would you need to be able to make an investment decision?"). This would help to enquire about anything that could be missing from the toolkit that an LSP may need to be able to make an informed decision on the use of the RailRunner system.

#### Other toolkit additions and modifications

The interviewee stated that, as a business development executive, they have the power to implement any transport solution that they see fit. This applies to any other business development executive. The role of business development executive was therefore added to the stakeholder analysis as a key player. Furthermore, they said that the divisional board would have to sign off on the decision to invest in RailRunner trailers. Even though the divisional board has a lot of power in the decision, they have little interest if there is a strong business case for the use of RailRunner technology. The role of the divisional board was therefore added to the list of people that need to be kept satisfied in the stakeholder analysis.

An addition made to the "Frequently asked questions" section (7.8) is the question of "Can regular trailers be converted into RailRunner trailers?". RailRunner South Africa said that it would be more expensive to convert an existing trailer into a RailRunner trailer than it would be to trade it in for a RailRunner trailer and pay in the remaining difference.

### 6.3.4 Exploratory interview four: Subject matter expert (freight owner)

#### Interviewee description

This interviewee is associated with a freight-owning company (retail) but chose to speak as a subject matter expert. They work as the operations manager for transport, and they focus on transport contract management. This means that they focus on the contracts with the LSPs that transport their freight. The company that they are associated with does not own any vehicles; they subcontract long-haul and short-haul LSPs. A summary of the interviewee and the company that they are associated with can be seen in Table 6.16.

TABLE 6.16: *Interviewee description summary*

| | |
|---|---|
| Job title | Operations manager for transport with a focus on transport contract management. |
| Speaking | As a subject matter expert in the transport industry. |
| Commodities transported | Clothing, jewellery, footwear, home appliances, furniture, and technology (phones tablets etc.). |
| Mode used | Mostly road, rarely air and sea. |
| Number of trucks used | Subcontract 13–15 long-distance line-haul vehicles per day. |
| Based in | Cape Town. |
| Operates | All over South Africa with high volumes over the Capecor and Natcor. |
| Types of trailers used | Hard body trailers only. |

#### Financial model

This interviewee stated that they do not deal with the detailed costs of transport, they are only interested in the final cost of transporting the freight. LSPs who focus on the long-haul segments would be more interested in the detail of the toolkit. Freight owners are more accustomed to looking at the whole picture instead of just one transport leg like the LSPs do. Their expertise lies in the final cost of moving freight and not how it is calculated. They stated that a price of around R24 000 is accurate for a superlink trailer to be transported on the Capecor.

### Decision matrix

The decision matrix as seen in Table 6.17 was constructed using the values for the levels of importance acquired from the answers to questions 11.1—11.12. These values were used as weights in the decision matrix. The ones and zeroes seen in the matrix represent the following opinions/perspectives of the interviewee:

1: Performs just as well as other systems with a value of 1.

0: Performs worse than other systems with a value of 1.

This interviewee was speaking from the perspective of a freight owner so the cost of investment in the RailRunner trailers was not a concern for them. Neither was the durability or political or financial stability of the country because they operated within South Africa on well-maintained roads.

The interviewee said that due to the nature of retail products, they must constantly move freight as soon as it is available. This is because they lose money if stock is not available to be sold in stores. The cost of transport would have to make up for any losses experienced due to slow transport. Therefore, they considered the cost of transport to be the one of the most important aspects.

Due to their reliance on a fast transport time, they would have to see a significant reduction in transport cost before they consider the use of the RailRunner system which is one day slower than road transport. They said that a reduction of 25% in transport costs would interest them but not 10%.

The reliability, speed and frequency of services would have the second-highest priority. An interesting point that they made was that they found flexibility to have a low weight since they would not be looking at transport methods involving rail if they were looking for flexibility.

Just like the other interviewees they expressed their doubts in the reliability of rail. They said that the reliability is a big problem for them, especially in South Africa where the maintenance of rail has been neglected for many years. They stated that the overwhelming consensus in the transport industry is that rail is a risky and unreliable form of transport. There needs to be a complete paradigm shift for rail to be successful.

They said that they like the advantages such as fast turnaround time in the terminal that the RailRunner system will be able to achieve. They also expressed their willingness to investigate rail, and they hope for rail to be a viable option in the future.

Considering the information above, one can see that the interviewee is open to the idea of using the RailRunner system but still has doubts about reliability. Their attitude is therefore accurately portrayed by the weighted total of the decision matrix. The values for road transport are only slightly higher than the transport methods involving the RailRunner system.

TABLE 6.17: *Decision matrix*

| | | | Transport methods | | | |
|---|---|---|---|---|---|---|
| | | Weight | DC-to-DC superlink | DC-to-DC 6 axle artic | Catching your own pass | DC-to-Terminal |
| Aspects of transport | Reliability | 4 | 1 | 1 | 0 | 0 |
| | Time/punctuality | 4 | 1 | 1 | 0 | 0 |
| | Frequency of services | 4 | 1 | 1 | 0 | 0 |
| | Cost (Investment) | 0 | 0 | 0 | 0 | 0 |
| | Cost (tonne-km) | 5 | 0 | 0 | 1 | 1 |
| | Flexibility | 2 | 1 | 1 | 0 | 0 |
| | Safety/security | 3 | 1 | 1 | 0 | 0 |
| | Environment | 3 | 0 | 0 | 1 | 1 |
| | Tracking (communication) | 5 | 0 | 0 | 1 | 1 |
| | Durability | 0 | 0 | 0 | 1 | 1 |
| | Political stability | 0 | 1 | 1 | 0 | 0 |
| | Financial stability | 0 | 1 | 1 | 0 | 0 |
| | Total | 30 | 7 | 7 | 4 | 4 |
| | Weighted total | | 17 | 17 | 13 | 13 |

### Additions and modifications to interview structure

No new or unforeseen topics were discussed in this interview therefore no additions or modifications were made to the structure of the interview.

### Other toolkit additions and modifications

In terms of stakeholders, the interviewee said that they have a larger say in what means of transport their contracted LSP uses only because they are the largest customer of that LSP. They also have a high level of interest in the transport method used because of the fragile nature of the commodities that they need transported. They stated that the head of transport and head of logistics in the freight-owning company would manage the decision to use RailRunner technology. These roles were added to the list of potential stakeholders in the stakeholder analysis.

Conventionally the LSP would have the larger say in what method of transport they use. This is because the LSP usually has many customers that need to be kept satisfied instead of just one. Freight owners with freight that is less sensitive to physical deterioration would also have a lower interest in the method of transport used. This interview showed that freight owners can have a varying amount of power or interest in the decision to use the RailRunner system.

## 6.3.5 Exploratory interview five: Consultant

### Interviewee description

This interviewee has worked in the logistics and supply chain industry for more than 20 years. They have also run their own rail business in the past. They specialise in freight transport throughout sub-Saharan Africa. They chose to distance themselves from any particular LSP and rather speak as a subject matter expert in the road and rail industry. A summary of the interviewee can be seen in Table 6.18.

TABLE 6.18: *Interviewee description summary*

| | |
|---|---|
| Job title | Currently working as a consultant for a large LSP. |
| Speaking | As an expert in the transport industry. |
| Commodities transported | Specialises in the transport of containerised goods, liquid fuel, and mining. |
| Mode used | Road and rail. |

### Financial model

The interviewee said that the price of rail transport may not be as low as it is in the financial model (30 cents per tonne-km) for countries in Africa other than South Africa. They explained that the price of fuel on rail alone is about seven cents per tonne-km. They also said that only the access fee of using rail outside South Africa is about 75 cents per tonne-km. Fortunately RailRunner South Africa has signed a contract with Transnet Freight Rail (South Africa's state-owned rail transport company) that will allow them to operate with such low transport costs on rail in South Africa.

### Decision matrix

The interviewee chose to rather talk about the importance of the various aspects of transport, depending on the commodities being transported. The following list shows what they said about the various aspects:

- **Time/punctuality**: Critical for cold chain commodities (which are usually time-sensitive);
- **Cost (tonne-km)**: Important for the transport of bulk commodities like palettes of bricks;
- **Flexibility**: Trivial/unimportant for the transport of large volumes of bulk commodities;
- **Safety/security**: Critical for the transport of hazardous materials such as liquid fuel.

Furthermore, the interviewee elaborated on the unimportance of the flexibility of transporting large volumes of bulk commodities. They described an example situation where 30 000 tonnes of iron ore had to be moved over a period of one month. In situations like this, it would not matter if 1 000 tonnes were moved every day or at other times 2 000 tonnes were moved every other day.

The interviewee also elaborated on the cost of transport, stating that a low cost of transport would have to make up for the drawbacks of rail such as speed, especially for time-sensitive freight. They stated that a lower transport cost would be needed for a product that is more time-sensitive.

The importance of reliability of DC-to-DC transport was also brought up by the interviewee. They stated that the scheduling of the loading and unloading periods at the DCs is important for efficient freight flow. This process could be interrupted by unreliable rail transport.

### Additions and modifications to interview structure

No new or unforeseen topics were discussed in this interview, therefore no additions or modifications were made to the structure of the interview.

### Other toolkit additions and modifications

The interviewee stated that freight owners do not have an interest in how their goods are transported. They only care about the price, reliability/predictability, and the frequency of the transport. What mode of transport the LSP uses is up to them. This confirms what interviewee four said which is that freight owners with freight that is less sensitive to physical deterioration will have a lower interest in the method of transport used. The interviewee in this interview specialises in the transport of freight that is less sensitive to deterioration such as containerised goods, liquid fuel and mining. This further solidifies their claims. The above information confirms that, much like the conclusion drawn by the fourth exploratory interview, the freight owners could have a varying amount of power and interest in the method of transport used.

A point that the interviewee made was that seasonal loads may have a problem if the trailers cannot be used out of season. This applies in situations where the load of one season, such as grain, could be contaminated by the load transported out of season, such as coal. Furthermore, the investment in RailRunner trailers may become a risk if they cannot be sold off to other LSPs. Equipment such as reach stackers can easily be sold and used elsewhere if their use is no longer needed, unlike RailRunner trailers that currently have a small if not non-existent resale market. RailRunner South Africa stated that investors would be able to sell the trailers to the North American market. This information was added to the Frequently asked questions section in the toolkit.

## 6.4 Chapter conclusion

This chapter looked at the exploratory interviews done to gain information that could be used to develop the finalised toolkit. Each interview contributed to the toolkit and the structure of the interviews that followed. Interviews were conducted until the toolkit reached a satisfactory level of completion and minimal additions were made after each interview. This process is demonstrated in Figure 6.4. It must be noted that a wide range of subject matter experts with varying areas of expertise was interviewed to gain the largest amount of information from different areas of the transport industry.

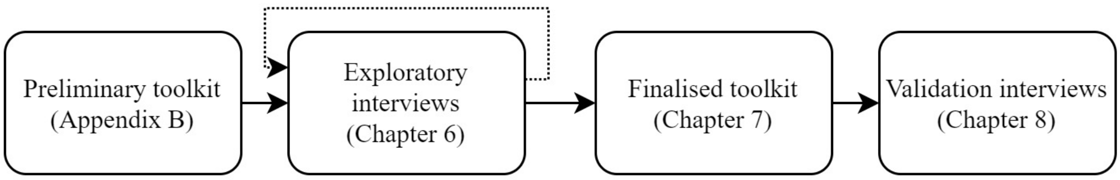


FIGURE 6.4: *Toolkit flow of completion*

This chapter forms part of the input to research objective four (finalised toolkit) as seen in Section 1.4.4.

# CHAPTER 7

# Finalised toolkit

Contents



## 7.1 Introduction

This chapter discusses the finalised toolkit. The first section (Section 7.1) and last section (Section 7.10) of this chapter do not from part of the toolkit. This is elaborated on in Table 7.1. The toolkit will be provided in the form of a separate document (including Sections 7.2 - 7.9) so that anyone that wants to use the toolkit can do so without the need for this whole thesis. Some information from earlier in this thesis may be repeated in this chapter since it is written to be a stand-alone document. Table 7.1 also shows which chapters / appendices were used to construct the various tools in the toolkit.

TABLE 7.1: *Chapter 7 inputs and structure*

| Section number | Input chapters | Part of the final toolkit? |
|---|---|---|
| 7.1 | NA | No |
| 7.2 | NA | Yes |
| 7.3 | Chapter 4 | Yes |
| 7.4 | Chapter 5 | Yes |
| 7.5 | Chapter 6 | Yes |
| 7.6 | Chapter 2<br>Chapter 6 | Yes |
| 7.7 | Chapter 3<br>Chapter 6 | Yes |
| 7.8 | Chapter 6 | Yes |
| 7.9 | NA | Yes |
| 7.10 | NA | No |

A decision was made to place the preliminary toolkit in Appendix B while the finalised toolkit is included in the main body of the thesis. This is done to avoid the redundant process of explaining some aspects of the toolkit twice. The process of finalizing the toolkit can be seen in Figure 7.1.

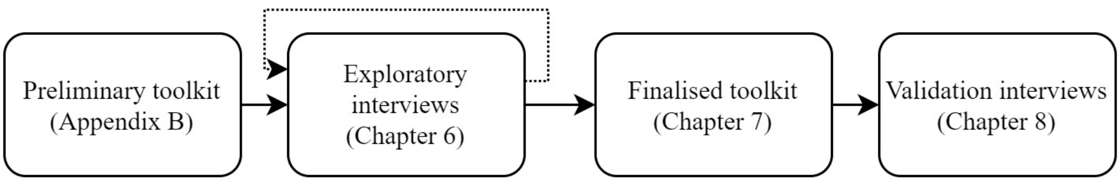


FIGURE 7.1: *Toolkit flow of completion*

This chapter aims to achieve research objective four (Finalised toolkit) as seen in Figure 1.7.

## 7.2 Toolkit introduction

This toolkit is intended to be used by LSPs to assess the benefits and drawbacks of using the RailRunner system for their freight transport operations. An accompanying spreadsheet is provided for the tools that require user interaction (financial model and decision matrix). The spreadsheet is populated with example values that were obtained from previous research and values suggested by various subject matter experts. This toolkit was developed by Daniël van der Merwe as part of his engineering management master's thesis. It contains the tools listed below:

- A section explaining what the RailRunner system/technology is (Section 7.3);
- Selection criteria for LSPs that can benefit from the RailRunner system (7.4);
- Stakeholder analysis on the role players that may have an interest or influence on the decision to use the RailRunner system (Section 7.5);
- Financial model comparing the operating costs of road-only systems with systems involving the RailRunner technology (Section 7.6);
- Decision matrix that assists LSPs to quantify and visualise their attitudes towards different transport methods (Section 7.7);
- A section on frequently asked questions that helps to clear up any misconceptions of the RailRunner system or technology (Section 7.8).

The toolkit was developed with the knowledge gained from research done on the road and rail industry in South Africa and abroad. The research includes the analysis of past literature as well as exploratory interviews done with subject matter experts.

## 7.3 The RailRunner system/technology

### 7.3.1 RailRunner company

RailRunner is a company that was started in North America and after extensive development, testing, and initial commercial operation, is now implementing their solution in North America, India, Egypt and most recently, South Africa.

In this document "RailRunner North America", is used to describe the parent company started in North America and "RailRunner South Africa", is used to describe the branch of the company based in South Africa. The term "RailRunner", is used when referring to the systems or technology that RailRunner implements regardless of the geographical area in which they operate.

### 7.3.2 RailRunner components and assembly

#### Components

The technology that RailRunner implements is an example of a roadrailer. A roadrailer is defined as "a vehicle that can run on both road and rail" (*Oxford Dictionary* 2020). The RailRunner system involves the use of rail bogies and specialised truck trailers (referred to as RailRunner trailers) that link together to form train segments as seen in Figures 7.2, 7.3 and 7.4. These specialised truck trailers can be in the form of box trailers, curtain sides, tippers or almost any other conventional form of tri-axle truck trailer.

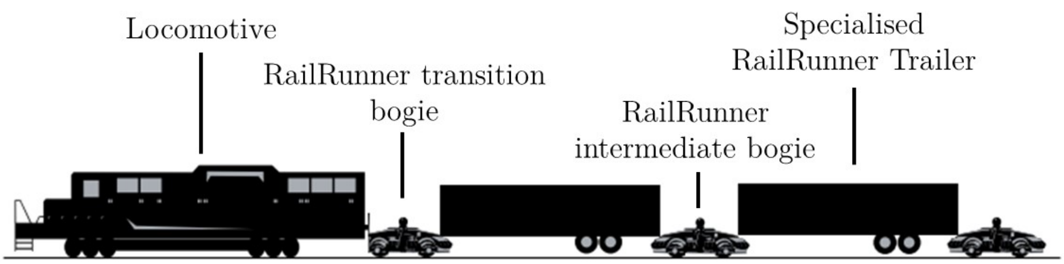


FIGURE 7.2: *RailRunner assembly (RailRunner, n.d.[a])*

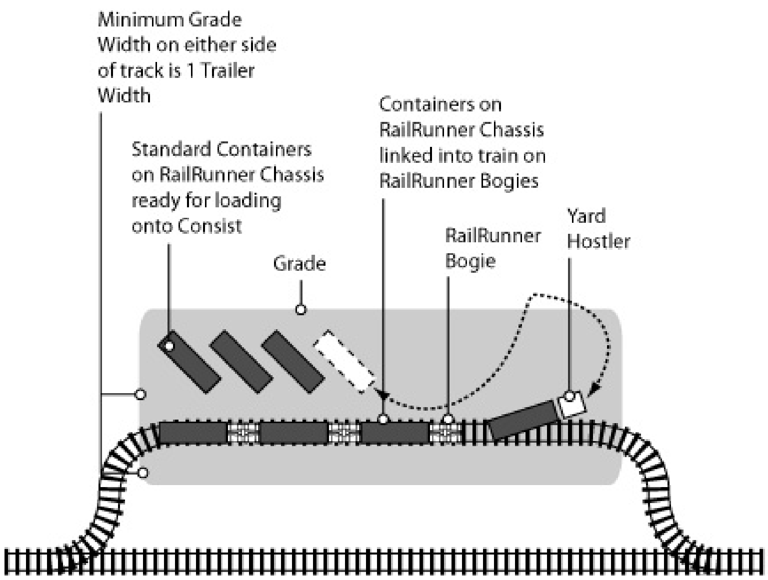


FIGURE 7.3: *RailRunner Terminal Anywhere$^{TM}$ system (RailRunner, n.d.[b])*

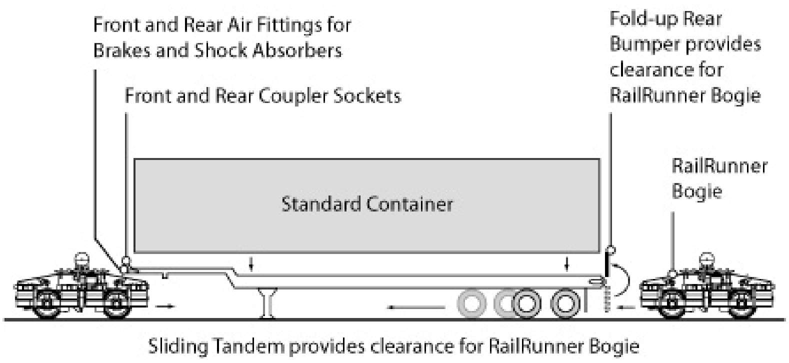


FIGURE 7.4: *RailRunner trailer and bogie system (RailRunner, n.d.[b])*

The following list explains the main differences between a conventional truck trailer and a RailRunner trailer:

- RailRunner South Africa trailers are a maximum of 13,65 metres long. RailRunner South Africa is currently working on approving the use of longer trailers. The length of trailers is limited due to the turning radius, as well as the vertical curves of hills and valleys of the installed Cape gauge rail in South Africa.
- RailRunner trailers have a connector on both ends that allows the trailers to connect to the bogies.
- RailRunner trailers are strengthened to withstand the forces that they will experience while on rail. The trailers closest to the locomotive have to withstand the tension and compression forces that all the other trailers behind them impose on them when the train accelerates and decelerates, respectively.
- Lastly, an air pipe and electrical cables run through the trailers for the operation of the air brakes on the bogies.

An example of a fully assembled RailRunner train including a locomotive can be seen in Figure 7.5.

FIGURE 7.5: *Assembled RailRunner train (RailRunner, 2021d)*

**Assembly of a RailRunner train**

The following list of steps and the accompanying Figure 7.6 explain the process of assembling a RailRunner train.

1. A tractor positions a RailRunner trailer on the track and backs it onto a RailRunner bogie. As the trailer slides onto the bogie, the trailer wheels lift off the track. Once the trailer is positioned on the bogie, a locking pin on the bogie automatically attaches the trailer to the bogie. The tractor then detaches from the trailer, leaving it on landing gear.
2. The tractor repeats step one for a second RailRunner trailer and bogie.
3. The tractor backs the entire second trailer, consisting of the combined trailer and bogie, into the front of the first trailer. As the second bogie connects to the first trailer, the

landing gear of the first trailer raises clear of the track. No manual rising of the landing gear is required.

4. The tractor disengages from the trailer and repeats the above process until the entire RailRunner train is ready for the locomotive.

5. The rail locomotive backs a RailRunner transition bogie into the assembled train. Air hoses are connected and airbags on all the RailRunner bogies are activated, further raising all the trailers on the train clear of rail and cushioning the cargo. The train then departs from the terminal. (RailRunner, n.d.[a])

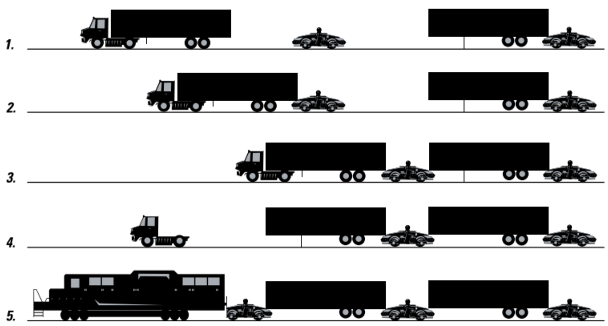


FIGURE 7.6: *RailRunner assembly (RailRunner, n.d.[a])*

### 7.3.3 Advantages over conventional bimodal road-to-rail systems

Less equipment is needed to set up a RailRunner terminal. Unlike conventional intermodal rail terminals, large cranes are not necessary for the movement of containers or loose cargo. The only equipment that is needed to set up a terminal is as follows:

- A tractor or yard hostler to move trailers for assembly and disassembly of RailRunner trains;
- An air compressor capable of supplying 120 PSI of compressed air for the air suspension of the bogies;
- A forklift with 7 300 kg of lifting capacity for moving bogies on and off the track.

Any truck driver and rail yard worker can easily assemble a train consisting of 40 trailers in four hours. There are numerous other smaller advantages of the RailRunner system such as the following:

- Airbag suspension and radial steering on the bogies lower noise and increase stability, reducing the risk of damage to freight;
- When the train is assembled, the doors of shipping containers being transported cannot be opened. This reduces the risk of theft (RailRunner, 2021f);
- When the RailRunner train is assembled, the space between the trailers is 0,7 meters compared to 3,3 metres in Containers-On-Flat-Cars (COFC) systems. This allows for more trailers to be transported on the same length train. The smaller distance between containers also reduces the wind resistance of the train (RailRunner, 2021e).

### 7.3.4 Possible disadvantages of the RailRunner system

There are some possible disadvantages to using the RailRunner system compared to using traditional bimodal transport involving Containers-On-Flat-Cars (COFC). This section discusses these disadvantages and how RailRunner South Africa intends to mitigate them.

#### Empty back-haul of trailers and bogies

**Possible disadvantage:** Multiple empty skeletal RailRunner trailers cannot be transported on rail. This is because the bogies need to carry a minimum amount of weight to travel safely on rail. If this minimum weight requirement is not met, then the bogies could potentially derail. Similarly, since bogies need to carry a certain amount of weight to be transported, there could also be a problem with empty bogie relocation. A RailRunner train consisting only of empty trailers will therefore not be a viable configuration.

**Mitigation:** One way to get around this problem is to place one empty skeletal trailer between two loaded trailers. This allows empty trailers to be transported while still meeting the minimum weight-bearing requirements of the bogies. RailRunner South Africa states that it would be preferable to sell the space on a trailer at a 50%—70% discount to relocate the trailer. It can then be used to transport a different load at 100% of the going rate.

Empty skeletalRailRunner trailers could also be used for the repositioning of empty shipping containers on the Capecor and Natcor. This would be useful since there are major freight imbalances on these corridors (GAIN Group, 2020).

Another way to avoid this problem is to make use of a liquid bulk bladder as seen in Figure 7.7. The bladder could be filled with water and strapped onto a truck trailer to fulfil the minimum weight requirements when on rail. The bladder could be rolled up and stored in a box underneath the trailer when not in use. This also opens a possibility for bulk liquids to be transported in one direction while, for example, transporting palletised goods in another direction.

FIGURE 7.7: *Liquid bladder in truck trailer (Ancra New Zealand Ltd, 2021)*

Lastly, empty bogies could also be loaded onto empty skeletaltrailers on the train. This would allow empty trailers and unused bogies to be transported at the same time without any chance of derailment due to weight requirements that are not met.

It is important to note that only empty skeletal trailers cannot be transported on rail. Skeletal trailers carrying empty shipping containers and any other trailer configuration including curtain side, box, flatbed, tipper, and reefer trailers, can safely be transported on rail even when empty.

### Mechanical failure

**Possible disadvantage:** One cause for concern is the increased risk of failure of systems on the train if equipment is not properly maintained. Some RailRunner trailers will be owned by LSPs. If the LSPs do not maintain the trailers properly, the air pipes or electrical cables could become dysfunctional. This could cause a failure of the air brake systems on the bogies which would hinder the train's ability to slow down. This could cause the train to derail on sharp curves or collide with other trains or equipment. If a large-scale accident were to occur due to system failure, long-lasting negative connotations could be associated with the technology causing LSPs to lose interest.

**Mitigation:** RailRunner South Africa states that all RailRunner trailers will have to go through a roadworthy and railworthy inspection annually. Similarly, RailRunner bogies will also need to go through an annual railworthy inspection. This would prevent the deterioration of equipment that could lead to a mechanical failure.

RailRunner South Africa states that half of the bogies' brakes in a train could fail, and it would still have enough braking power to operate safely. Furthermore, they state that if the air suspension were to fail then one could easily replace the airbags with temporary spring suspension until the airbags can be replaced.

The trailers are also strengthened to such a degree that they can withstand the tension forces of 150 other fully loaded trailers being pulled behind it while on rail. This shows that the trailers are strong enough to withstand the forces that they will experience in South Africa since a maximum of 50 trailers will be used on local trains. Furthermore, through using the brakes on the bogies, the trailers will never experience excessive compressive forces of other trailers imposed on them while on rail.

If a mechanical failure were to happen, the train would be able to stop at a terminal or road level crossing so that any compromised trailers could be removed. The train could then continue its journey. This, however, is extremely unlikely to happen given the rigorous certification processes that the trailers and bogies would have to go through to ensure safe use on rail.

### Significant delays

**Possible disadvantage:** A concern that many LSPs or freight owners may have, is the possibility of significant delays on rail due to unreliable service from Transnet (South Africa's state-owned rail company). Transnet has a long history of questionable service and neglect of proper maintenance on infrastructure (Business Insider, 2021).

**Mitigation:** RailRunner South Africa states that if a delay were to occur, and time-sensitive freight requires immediate transport, they would be able to send a truck to the terminal where the train is waiting. The trailer could then easily be removed from the train and be transported the rest of the way to the destination via road without significant loss in transport time.

A network of truck owners would be established along the transport corridor to allow for fast response times. This would ensure that trucks are always available to transport RailRunner trailers if necessary. RailRunner would carry the cost of this service so that the freight owner would not be disadvantaged.

A "draw bar", which is of equal strength to a RailRunner trailer, could then be used to connect the two bogies that were previously transporting the trailer. The train could then travel the rest of the way to the destination terminal once the problem causing the delay has been cleared up.

This system could also be used at times when Transnet is doing maintenance on a section of the rail line. RailRunner South Africa would be able to set up temporary terminals on either side of the section that is undergoing maintenance and easily move the trailers via road from one terminal to the other. This method could also be used to cross borders where it is difficult for trains to get approval for entry. Another example could be when RailRunner trailers need to be moved from one rail gauge to another. This could be useful in North Africa where two rail gauges meet.

#### Conversion of regular trailers into RailRunner trailers

**Possible disadvantage:** Regular trailers cannot be strengthened and converted into RailRunner trailers. RailRunner South Africa states that this process would be more costly than building a new RailRunner trailer from scratch and selling the old regular trailer.

**Mitigation:** A trade-in system could be used to allow users to trade in their regular trailer for a RailRunner trailer while paying the difference in price. Alternatively LSPs can replace their old regular trailers with RailRunner trailers as they become obsolete.

#### Decreased carrying capacity

**Possible disadvantage:** RailRunner trailers are strengthened to withstand the forces that they will experience while on rail. This adds extra material and weight to the trailer which in turn lowers the weight of the load that the trailer is legally allowed to carry on road. A RailRunner trailer is approximately 5 tonnes heavier than a conventional trailer which means that its maximum load capacity is about 24 tonnes. RailRunner South Africa still needs to provide more precise values.

**Mitigation:** This problem does limit the RailRunner South Africa's customer base to a small degree. RailRunner South Africa states that they will try to make the RailRunner trailers as lightweight as possible so that LSPs can carry heavier payloads. RailRunner South Africa states that they will still be able to provide their services to most of the market in South Africa given these weight limitations.

### 7.3.5 RailRunner in South Africa

In 2016 RailRunner South Africa signed a contract with Transnet Ltd (South Africa's state-owned rail transport company) to be able to implement their bimodal solution on railway lines in South Africa. This is in line with Transnet's market demand strategy that involves the moving of traffic from South Africa's congested highway network to rail (RailRunner, 2021c). Transnet's market demand strategy involves a R300 billion investment from the government and aims to modernise South Africa's ports, pipelines, and rail (Transnet, 2021). According to RailRunner South Africa's proposed business model, they will be managing the building, breaking, loading, and delivering of the train (and any other operations in the terminal) while Transnet will only be doing the hook and haul of the train set from terminal to terminal.

#### RailRunner's plan for the South African market

RailRunner South Africa plans to implement their solution on the Capecor first, and then move on to other corridors like the Natcor and the North-South corridor that runs from Gauteng into the rest of Africa. On the Capecor they intend to have a set of two trains of 40—50 trailers leaving Johannesburg and Cape Town respectively every day. Another set of two trains will also be arriving in Johannesburg and Cape Town every day. Lastly, there will be at least two trains on the rail track between the two locations every day. Therefore, 6 trains will either be arriving at, leaving from, or travelling between, Cape Town and Johannesburg every day.

The Natcor will operate similarly to the Capecor, but it will operate with one less set of trains since the travel time on this corridor is less. It must also be noted that another 40—50 trailers will be moving by road every day to collect / deliver freight around the different terminals. This applies to both corridors.

RailRunner South Africa hopes to one day be able to run trains that can travel from Cape Town to Johannesburg in less than a day (22 hours). The main problem with this is that there are three rail power systems on the route between Cape Town and Johannesburg. This results in the need for locomotives to be swapped for each power system along the route, causing significant increases in travel time. If Transnet were to run a regularly scheduled service for RailRunner South Africa, then they would have to find a way to improve the efficiency and reliability of switching locomotives.

For allocating space on a train, RailRunner South Africa intends to operate on an airline-based model where clients will pay different rates based on how quickly they would like to have their freight delivered. Trailers loaded with freight will be dropped off at terminals and will then be sent off with the next available train depending on the transport time agreed upon by the customer.

RailRunner also intends to implement their solution in the mining sector which predominantly involves the transport of coal. For the scope of this toolkit, however, the focus will be on the Capecor and other transport corridors in South Africa.

#### Company structure

There are several companies involved in the use of the RailRunner system. Figure 7.8 shows the proposed structure of these companies. RailRunner South Africa has a contract with Transnet to haul the RailRunner trailers. RailRunner South Africa also owns the RailRunner service company. The RailRunner Service Company will manage all terminal operations and serve as a service provider to LSPs. Lastly the LSPs are the service providers to the freight owners.

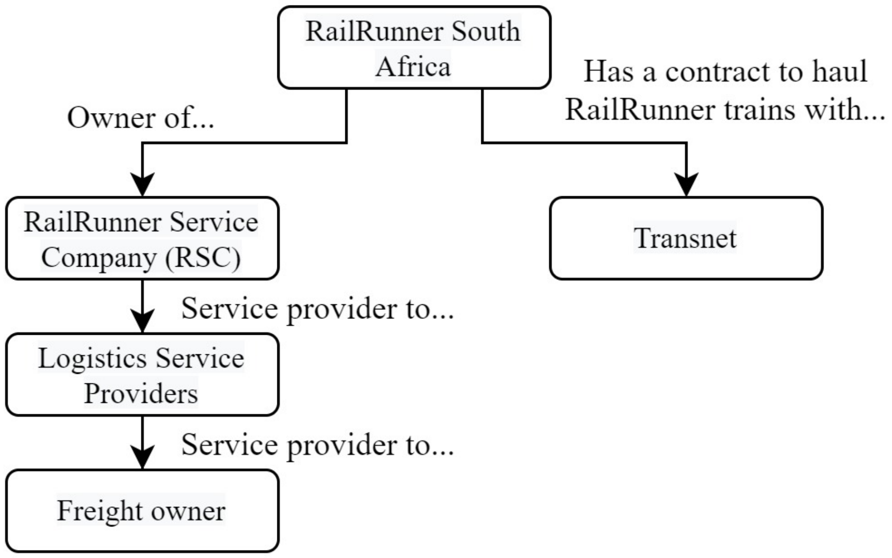


FIGURE 7.8: *RailRunner company structure*

### 7.3.6 RailRunner's Terminal Anywhere™ solution

RailRunner uses the trademarked term "Terminal Anywhere™". This represents their technology that can be used to set up terminals with low investment costs as well as low operational costs. RailRunner provides the necessary software for the management of the terminals. This includes the necessary information on maintenance and refurbishment, building and disassembling RailRunner trains, and the management of terminal logistics (RailRunner, 2021g). The following infrastructure is needed to set up a RailRunner terminal:

- Rail siding that is 10% longer than the intended length of the train;
- Flat surface next to, and in-between the rail tracks that is level with the track. This is so that the trailers can be manoeuvred over the track to be connected to the bogies. This surface must be at least one trailer width wide on each side of the track as demonstrated in Figure 7.3;
- Storage area for trailers waiting to be transported and unused bogies;
- Securely fenced terminal area with an office that has an internet connection;
- Software for managing daily operations.

This system allows intermodal transport to be made available to freight owners that are not located close to large established intermodal terminals. When freight volumes are inconsistent, LSPs usually resort to using more expensive road transport instead of rail. With the use of the Terminal Anywhere™ solution, a temporary terminal could be set up when freight volumes are high. This is particularly useful for the transport of seasonal freight such as agricultural products where freight volumes differ depending on the time of year (RailRunner, 2021g).

It must also be mentioned that terminals with high and consistent transport volumes can also be set up. These terminals are large and permanently operational unlike the more temporary terminals that Terminal Anywhere™ technology makes possible. These terminals can handle the same volumes of freight as conventional bimodal terminals at lower investment and operational costs.

## 7.4 Selection criteria

This section outlines selection criteria for potential users (LSPs) of the RailRunner system. This can be used to identify companies that will be able to use the RailRunner system, and benefit from using it.

It is difficult to construct selection criteria that provide definite answers to the suitability of the use of bimodal transport. Therefore, a five-point scale will be used to describe the importance of each criterion (with five being the most important). An adjective and definition are assigned to each of these five levels of importance. This is done so that each criterion can be discussed using these adjectives instead of using ambiguous numbers. The levels of importance and their assigned adjectives and definitions are listed below:

- **5: Crucial**: Bimodal transport will not be viable if this criterion is not met;
- **4: Important**: A large influence on the viability of bimodal transport;
- **3: Preferable**: A notable influence on the viability of bimodal transport;
- **2: Relevant**: A small influence on the viability of bimodal transport;
- **1: Minimal**: Has minimal influence on the viability of bimodal transport.

The selection criteria in this section are grouped into the following two categories:

- Transport characteristics;
- Commodities / commodity characteristics.

It must also be noted that some criteria may be more important depending on which bimodal system is used. COFC and RailRunner / roadrailer technology have differences that could influence the importance of certain criteria. This chapter will therefore take both COFC, and RailRunner / roadrailer technology into account.

### 7.4.1 Transport characteristics

Table 7.2 lists characteristics of transport that are favourable for the use of intermodal transport. Each criterion has an ID that is linked to discussions in this subsection.

TABLE 7.2: *Transport characteristics selection criteria*

| | | Importance | |
|---|---|---|---|
| ID | Criterion for viable bimodal transport | COFC | Roadrailer / RailRunner |
| A1 | Transport distance:<br>Greater than 500 km | Crucial | Crucial |
| A2 | Transport volume:<br>Greater than 100 000 tonnes per annum | Crucial | Important |
| A3 | Transport routes:<br>Capecor or Natcor | Important | Preferable |
| A4 | Origin and destination proximity to terminals:<br>Must be close (exact distance uncertain) | Crucial | Preferable |
| A5 | Transport demand:<br>Demand is stable and predictable | Crucial | Preferable |
| A6 | Safety requirements of freight:<br>Low risk of theft, breakage, or physical deterioration | Crucial | Preferable |
| A7 | Other costs:<br>Transport that does not incur high costs other than transport cost (insurance, interest, storage cost etc.) | Crucial | Crucial |
| A8 | Freight packaging material/methods:<br>No expensive packaging required | Important | Relevant |
| A9 | Freight transport time flexibility:<br>Must be flexible | Important | Preferable |

**A1 Transport distance:**

Previous research suggests a minimum of 500 km is needed for road-to-rail bimodal transport to be profitable due to the increased cost of moving the freight between modes (Behrends (2017), Havenga, Z. P. Simpson, Fourie, et al. (2011)). This is a **crucial** criterion for COFC and RailRunner technology. RailRunner may have a smaller viable distance due to their increased flexibility, but insufficient research has been done to provide a comprehensive figure.

**A2 Transport volumes:**

To justify the building of terminals and the standardisation of processes, a minimum of 100 000 tonnes of freight needs to be transported per year (Havenga, Z. P. Simpson, Fourie, et al., 2011). This is equivalent to one round train trip per week as calculated in Table 7.3. It is roughly the amount that Transnet Freight Rail (South Africa's state-owned rail transport company) would like to be sure of so that the construction of infrastructure and the purchase of locomotives and rolling stock (wagons) can be justified. Currently, Transnet requires a single user to have the required 100 000 tonnes. It is therefore **crucial** for the conventional COFC system to have these required volumes. The RailRunner system enables multiple LSPs to make use of the same locomotives. This allows for smaller volumes from multiple users to be consolidated to reach the threshold volume. This criterion is therefore only **relevant** to the RailRunner system.

Table 7.3: *Round trip train transport volume per year*

| Variable | Value |
|---|---|
| Tonnes per trailer | 24 |
| Trailers per train | 40 |
| One-way trains per year | 52 |
| One-way train transport volume per year | 49 920 |
| Round trip train transport volume per year | 99 840 |

**A3 Transport routes:**

Most of the freight in South Africa (excluding mining) flows along the Capecor and the Natcor (Havenga, Z. P. Simpson, King, D. de Bod, et al., 2016). As a result, the major portion of operational rail and terminal infrastructure is also along these corridors. It is especially important for COFC to have terminal infrastructure in place. It is therefore **important** that the transport of freight needs to be along these routes for the use of COFC. RailRunner, however, is not limited to transporting freight between large established terminals. They can construct cheap and efficient terminals wherever and whenever demand for transport is high (RailRunner, 2021g). Some examples of this include the seasonal citrus transport from Tzaneen to Durban and the seasonal transport of grain from the Free State province. Therefore, the transport of freight along these routes is only **preferable** for RailRunner to transport freight on the Capecor and Natcor.

**A4 Origin and destination proximity to terminals:**

It is **crucial** for the origin and destination of freight moved using COFC to be close to rail terminals (González, Sánchez, and Romero, 2014). Like the criterion mentioned in Section 7.4.1, it would only be **preferable** for freight to be close to terminals if RailRunner is used since they can easily establish terminals if needed (RailRunner, 2021g). Some subject matter experts suggest that the distance of the origin and destination of the freight needs to be within 50 km of rail terminals.

**A5 Transport demand:**

This criterion is linked to criterion A3 (Transport routes). The demand for transport needs to be stable and predictable (Vogt et al., 2005) as seen on the Capecor and Natcor. This is because of the inflexibility of rail. Trains can only travel between established terminals on well-maintained rail lines. The fact that terminals cannot be easily constructed for COFC makes this criterion **crucial** for its viability but only **preferable** for RailRunner. This is because of RailRunner's Terminal Anywhere™ system.

**A6 Safety requirements of freight:**

Safety has a major influence on the choice of mode of transport for LSPs. The safety of transport is considered to be even more important than the transport cost (Andersen, 1995). Much like road transport, COFC transport has various safety problems. These include risk of theft, breakage, and physical deterioration. It is therefore **crucial** that COFC is used to transport freight that is less susceptible to these safety issues.

It must be reiterated that RailRunner has certain safety benefits. When a train is assembled, the doors of shipping containers being transported cannot be opened. This reduces the risk of theft (RailRunner, 2021f). Furthermore, airbag suspension and radial steering on the bogies lower noise and increase stability, reducing the risk of damage to freight. These advantages may assist RailRunner transport to be safer than COFC transport, and possibly even safer than road transport. It is therefore only **preferable** for RailRunner to be used for freight that is less susceptible to these safety problems.

**A7 Other costs:**

Road transport may outperform rail in some aspects. These include flexibility, service reliability, goods security, and total lead time. Freight that is negatively affected by poor performance in these aspects could lead to other costs. These costs include high insurance cost, carrying cost for additional safety stock, and interest (incurred due to longer transport times on rail). These costs would negate the cost saved from lower transport rates. It is therefore **crucial** for both COFC and RailRunner methods to transport freight that is not affected by poor performance in the aspects mentioned to keep these costs as low as possible.

**A8 Freight packaging material/methods:**

Another factor that could negate the cost savings achieved with bimodal technology, is the need for expensive packaging material/methods. COFC, for example, requires the products to be placed in a shipping container to be shifted between road and rail. Extra protective material may also have to be used when freight is transported on rail. RailRunner technology will allow the freight to be transported with mostly the same packaging that would be used if it were to be transported on road. It is therefore **important** for COFC, and only **relevant** to RailRunner that the freight being transported does not require any expensive packaging material/methods.

**A9 Transport time flexibility:**

The use of rail would be attractive to companies that are flexible in terms of transport times (González, Sánchez, and Romero, 2014). This is because of the increased risk of delays due to factors such as the extra operations required to shift the freight between modes. Furthermore, the unreliability of rail transport in South Africa brings its own set of time-delay risks (Business Insider, 2021). Therefore, freight that is flexible in terms of transport time requirements will be preferable. This is **important** for COFC, but only **preferable** for the use of RailRunner, since the RailRunner system allows for a faster shift from road to rail. RailRunner South Africa also states that they can remove a trailer from a train at a terminal along its journey and move it to its destination via road if a significant delay were to affect a time-sensitive load. This would require them to have a network of trucks on standby along the relevant transport corridor.

### 7.4.2 Commodities / commodity characteristics

This section will discuss a few characteristics of commodities that are better suited for bimodal transport. Table 7.4 provides a summary of the selection criteria discussed in this section. It outlines the commodities and properties of commodities that are best suited for the use of bimodal transport. Each criterion has an ID that is linked to discussions in this subsection.

TABLE 7.4: *Commodity characteristics selection criteria*

| | | Importance | |
|---|---|---|---|
| ID | Criterion for commodities potential users of bimodal transport | COFC | Roadrailer / RailRunner |
| B1 | Raw materials | Preferable | Relevant |
| B2 | Goods that can be palletised | Preferable | Relevant |
| B3 | Preferable commodities:<br>Processed foods;<br>Beverages;<br>Chemicals (Other);<br>Paper and paper products;<br>Wood and wood products. | Preferable | Preferable |
| B4 | Unwanted freight properties:<br>Perishable;<br>Subject to rapid ageing;<br>Required on short notice;<br>Valuable in relation to its mass;<br>Expensive to handle or store. | Crucial | Preferable |
| B5 | Falls under one of the following cargo types:<br>Agricultural dry bulk;<br>Heavy break bulk;<br>Light break bulk;<br>Liquid bulk;<br>Mining dry bulk;<br>Palletised;<br>Refrigerated;<br>RO-RO (Roll On Roll Off). | NA | Crucial |
| B6 | Hazardous materials. | Relevant | Relevant |

**B1 Raw materials:**

Trains are more likely to transport raw materials as opposed to the final products that end users consume (Pienaar, 2007). This includes raw materials such as grain and steel, as opposed to breakfast cereal and kitchen appliances. Raw materials are less sensitive to time delays and unreliable transport. It is therefore **preferable** for the COFC system to transport this freight because of its low flexibility and longer transport time. RailRunner South Africa is aiming for a higher flexibility and shorter transport time which enables them to transport more finished and semi-finished goods. Therefore, it is only **relevant** to RailRunner that the freight is further from being processed into finished and semi-finished goods.

**B2 Goods that can be palletised:**

Havenga, Z. P. Simpson, Fourie, et al. (2011) states that, to achieve standardisation of systems and increase transport density, it would be **preferable** for the freight being transported to be palletised. This is especially true for COFC because of the ease of packing and unpacking of shipping containers if freight is palletised. If the RailRunner system is used, then the truck trailers form part of the train. Therefore, the use of containers and pallets is not as necessary since less packing and unpacking of freight would have to be done. This criterion is therefore only **relevant** to RailRunner.

**B3 Preferable commodities:**

Trains are known to transport a wide range of commodities. However, some commodities are better suited for rail. According to research done by Van Eeden and Havenga (2010), the following commodities would be best suited for bimodal transport in South Africa:

- Processed foods;
- Beverages;
- Chemicals (other);
- Paper and paper products;
- Wood and wood products.

It is **preferable** for both COFC and RailRunner to transport these commodities since they can be palletised and have high volumes along the Capecor and Natcor.

**B4 Unwanted freight properties:**

Freight with certain properties that make it susceptible to unreliable transport cannot be transported using COFC due to its inflexibility and increased transport time. The use of RailRunner mitigates these problems to a large degree, but it is still **preferable** to avoid the transport of freight with the following properties:

- Perishable;
- Subject to rapid ageing;
- Required on short notice;
- Valuable in relation to its mass;
- Expensive to handle or store.

This criterion is **crucial** for COFC but only **preferable** for RailRunner.

**B5 Cargo types that RailRunner can transport:**

RailRunner trailers can be configured to transport certain cargo types. These trailer configurations include tipper, curtain side, box, flat-bed, reefer and Roll-On-Roll-Off (RO-RO). These trailer configurations can transport the following cargo types:

- Agricultural dry bulk;
- Heavy break bulk;
- Light break bulk;
- Liquid bulk;

- Mining dry bulk;
- Palletised;
- Refrigerated;
- RO-RO (Roll On Roll Off);

It is therefore **crucial** for freight to fall under one of these cargo types. The only cargo type that RailRunner is not able to transport is open skip bulk. It must also be noted that some of these cargo types may be easier to transport compared to others, although further research is needed to be able to determine which these are.

**B6 Hazardous materials:** One thing to consider is the transport of hazardous materials. Trains are considered as being the safer alternative to road transport (Bubbico, Di Cave, and Mazzarotta (2004), Rada, Ferronato, and Torretta (2017)). It is therefore **relevant** to both COFC and RailRunner to consider the transport of hazardous materials. This would help to alleviate collateral damage to the general population caused in trucking accidents since train track routes tend to avoid populated areas.

### 7.4.3 Concluding remarks

These selection criteria should be used in conjunction with each other to see if an LSP can successfully make use of the RailRunner system given their specific transport characteristics and commodities that they transport. It is important to note that these criteria should only be used as a guideline and not as a way of gaining a definitive answer on the usefulness of the RailRunner system for a specific LSP.

## 7.5 Stakeholder analysis

An important part of the decision to use RailRunner technology is the consideration of all the stakeholders that could have a say, or be interested in, the decision. A power-interest matrix is the best way to categorise stakeholders according to their level of power and interest. The structure of this matrix can be seen in Figure 7.9.

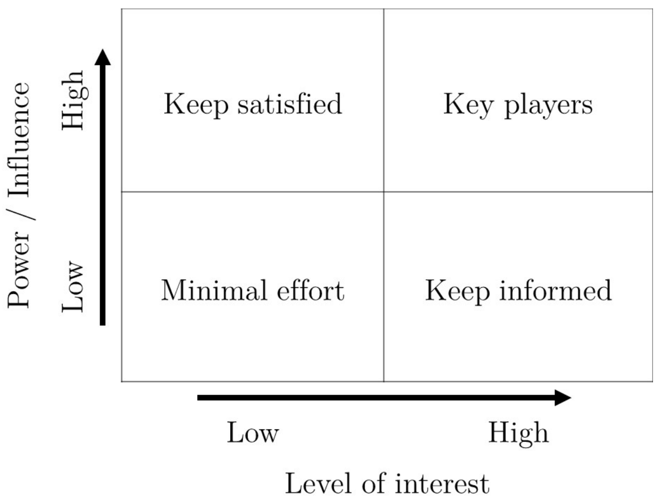


FIGURE 7.9: *Power-interest matrix (Mendelow, 1991)*

It is difficult, if not impossible, to construct a list of all the stakeholders that an LSP must consider. Therefore, some examples of stakeholders are listed below under the labels in the power-interest matrix. These examples could be used to assist when thinking of the specific stakeholders that need to be considered and kept track of when deciding on whether or not to use RailRunner technology.

Key players:

- Managing director;
- Majority shareholder;
- General manager;
- Business development executive.

Keep satisfied:

- Investors of the business (LSP);
- Divisional board in the LSP.

Keep informed:

- Head of transport (freight owner);
- Head of logistics (freight owner).

It must be noted that the freight owner(s) may have a varying level of power or interest in the decision to use the RailRunner system. If a freight owner is the main customer of an LSP then the freight owner may have a greater amount of power over what transport method the LSP uses. The freight owner could, for example, ask the freight owner to use the RailRunner system to be able to reduce carbon emissions. The freight owner may also have a higher level of interest if they have certain transport requirements. This could include, for example, the use of a more stable form of transport for fragile goods. Some subject matter experts suggest that freight owners do not have an interest in the mode of transport used. They only care about the price, reliability/predictability, and the frequency of the transport. This means that freight owners could be labelled as any of the four labels seen in Figure 7.9, and an individual decision needs to be made by each LSP for each freight owner when considering using the RailRunner technology. Their levels of power and interest should be gauged based on their involvement with the LSP that is transporting their freight as mentioned above.

## 7.6 Financial model

The best way to quantify the cost savings when using the RailRunner system is by using a financial model. This section will discuss a financial model that compares different methods of transport, some of which make use of the RailRunner system. These methods are discussed in Section 7.6.1. Section 7.6.2 discusses how the financial model should be interpreted. Lastly, Section 7.6.3 discusses the structure of the financial model and the calculations within it.

### 7.6.1 Methods of transport

The methods of transport compared in the financial model are as follows:

- DC-to-DC;
- Catching-your-own-pass;
- DC-to-terminal.

The DC-to-DC method is used as the control while the catching-your-own-pass and DC-to-terminal methods involve the use of RailRunner technology. Each of these methods is discussed in the subsections below.

#### DC-to-DC transport method

This method is the control case. It involves a truck that uses a regular trailer to move freight between DCs on road. The following process and the accompanying figure (7.10) describe this method:

1. The primary mover moves a full trailer from an origin DC/supplier to a destination DC via road.
2. The primary mover moves the empty trailer from the destination DC to the origin DC/supplier.


FIGURE 7.10: *DC-to-DC transport method*

A trip is completed when one cycle of the above process is completed. The trailer in this scenario is full on every trip since this is the market that RailRunner aims to tap into (no empty back-haul). A trip is completed when one cycle of this process is completed.

#### Catching-your-own-pass transport method

This method involves moving one regular trailer on road, and one or more RailRunner trailers on rail simultaneously. The following process and the accompanying figure (7.11) describe this method:

1. The primary mover moves a full trailer from an origin DC/supplier to a destination DC via road.
2. The primary mover goes to the terminal and moves a full RailRunner trailer back to the DC.
3. The empty trailers are moved to other DCs/suppliers so that they can be refilled.

4. The RailRunner trailers are moved back to the terminal so that they can be transported on rail to the destination terminal.

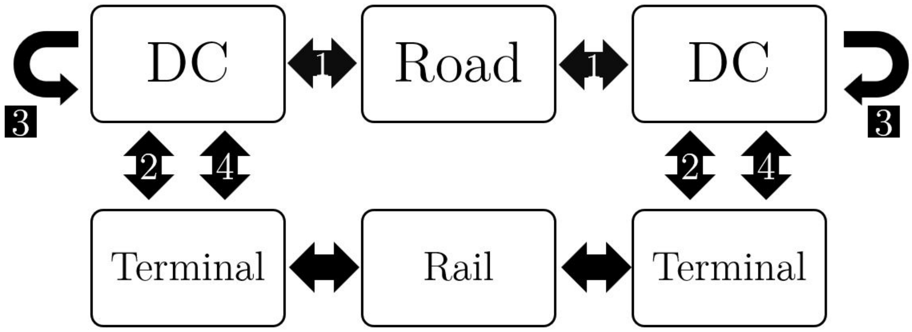


FIGURE 7.11: *Catching-your-own-pass transport method*

A trip is completed when one cycle of the above process is completed. The LSP can own multiple RailRunner trailers if they can be unloaded, loaded, and returned to the terminal before the next train leaves.

Note that some subject matter experts state that this method may be difficult to execute because of the precise timing required. This method may be better executed with the use of subcontracted vehicles that can be used whenever necessary.

**DC-to-terminal transport method**

This method involves two (or more) primary movers, each moving multiple RailRunner trailers between DCs/suppliers and terminals at the endpoint of each corridor. The following process and the accompanying figure (7.12) describe this method:

1. The primary mover moves a full RailRunner trailer from the terminal to the DC.

2. The empty trailers are moved to other DCs/suppliers so that they can be refilled.

3. The filled RailRunner trailers are moved back to the terminal.

4. The trailers are transported on rail to the destination terminal.

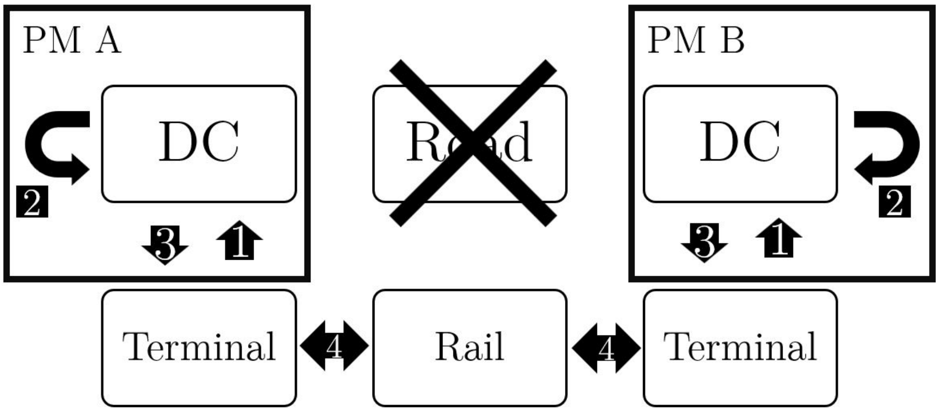


FIGURE 7.12: *DC-to-terminal transport method*

A trip is completed when one cycle of the above process is completed. The LSP can own multiple RailRunner trailers if they can be unloaded, loaded, and returned to the terminal before the next train leaves.

### 7.6.2 Financial model interpretation

The financial model is in the form of a spreadsheet. It contains multiple variables and calculations. This section discusses how each of these variables and calculations should be interpreted. Table 7.5 shows the key that should be used alongside the financial model.

TABLE 7.5: *Financial model key*

| | |
|---|---|
| | A white background represents a variable that can be changed. |
| | A light grey background represents calculations that only simplify the process of populating the table. These calculations can be overwritten by the user if they wish to do so. |
| **Bold** | A dark grey background with bold text represents a calculation that cannot be overwritten by the user. These calculations form part of the structure of the financial model. |
| NA | A black background with white text represents entries that are not applicable to the specific method of transport. |
| **>2%** | Above 2% change in tonne-km if a 20% change is made in the variable. |
| **>8%** | Above 8% change in tonne-km if a 20% change is made in the variable. |

Sensitivity analysis was done to determine how much influence an entry in the financial model has. Some rows in the financial model contain a “2%” or an “8%” in the right-hand column. These values indicate that if the values in that row change by 20%, then the overall cost per tonne-km (in row 122) changes by more than 2% or 8%.

The industry standard vehicle used in long-distance road freight transport is a 7—axle superlink. Therefore, it is included in the comparison with the 6—axle articulated vehicle that RailRunner

South Africa intends to use. An example of a 7—axle superlink (box trailer) and a 6—axle articulated vehicle (box trailer) can be seen in Figures 7.13 and 7.14, respectively.

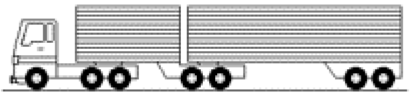

FIGURE 7.13: *7-axle superlink (box trailer)*

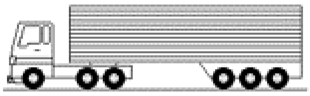

FIGURE 7.14: *6-axle articulated vehicle (box trailer)*

Since a RailRunner trailer in the form of a superlink is not a feasible option, it can only be used as a DC-to-DC transport method. It must also be stated that a 6-axle articulated vehicle is not commonly used for long-distance DC-to-DC road transport. It is only included in the financial model so that its values can be compared to those of other transport methods including RailRunner. The following transport methods are compared in the financial model:

- DC-to-DC (7-axle vehicle with a superlink trailer);
- DC-to-DC (6-axle vehicle with a regular tri-axle trailer);
- Catching your own pass (Uses one regular trailer and one or more RailRunner trailers);
- DC-terminal (Uses multiple RailRunner trailers only).

### 7.6.3 Financial model structure

This section discusses the variables and formulas used in the financial model. The financial model is made up of the following five parts:

- Assumptions;
- Capital cost;
- Standing cost;
- Variable cost;
- Comparison summary.

Each subsection below will discuss a different part of the financial model. Each of the subsections will contain a table showing the structure of the financial model which is accompanied by notes and recommended values for the variables in the table.

### Assumptions

The first section of the financial model establishes the assumptions made that the rest of the financial model is based on. Tables 7.6 and 7.7 show the variables and formulas used.

TABLE 7.6: *Financial model: Assumptions*

| 1/A | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|
| 3 | | Transport method | DC to DC (super link) | DC to DC (tri-axle) | Catching your own pass | DC to Terminal (2 primary movers) | |
| 4 | **ASSUMPTIONS** | | | | | | |
| 5 | | Number of RR trailers | NA | NA | | | >8% |
| 6 | | Average payload of RR trailer (Tons) | NA | NA | E7 | E7 | >2% |
| 7 | | Average payload of regular trailer (Tons) | | | E7 | NA | >8% |
| 8 | | **Total Average Payload (tons)** | **D7** | **E7** | **F7+F6 *F5** | **G6* G5** | >8% |
| 9 | | Deck length (metres) | | | E9 | E9 | |
| 10 | | Days to make one trip | | D10 | D10+1 | D10+1 | >2% |
| 11 | | Working days | | D11 | D11 | D11 | >2% |
| 12 | | **Number of trips made** | **D11/ D10** | **E11/ E10** | **F11/ F10** | **G11/ G10** | >2% |
| 13 | | Average distance travelled in one trip by regular trailer (km) | | D13 | D13 | NA | >8% |
| 14 | | **km per annum (regular trailer)** | **D13* D12** | **E13* E12** | **F13* F12** | NA | >8% |
| 15 | | Average distance travelled in one trip by RR trailer on road (km) | NA | NA | | F15 | |
| 16 | | **Km per annum (RR trailer) on road** | NA | NA | **F15* F12** | **G15* G12** | |
| 17 | | Average distance travelled in one trip by RR trailer on rail (km) | NA | NA | | F17 | >2% |

**Row 5 (Number of RailRunner trailers):** RailRunner South Africa states that a truck should be able to handle the collection, unloading, loading and delivery back to a terminal of four RailRunner trailers in one day. The primary mover in the catching-your-own-pass transport method would therefore be able to handle the movements of three RailRunner trailers and one regular trailer.

The following example can be used as a base model for calculating the number of RailRunner trailers that can be used in the DC-to-terminal method: If a trip takes three days (one day between DC and the terminal, one day on rail and one day between terminal and DC) then the DC-to-terminal system would be able to handle 16 RailRunner trailers. This number is calculated by adding up two sets of four RailRunner trailers between the origin and destination DCs and terminals, and two sets of four travelling on the rail between the origin and destination terminals as seen in Figure 7.15. This model can be expanded. If the time on rail were to be two days, then two extra sets of four trailers could be added to the system and so on. If the time to move trailers between the DCs and terminals were to be longer than one day, then the number of trailers would have to be decreased.

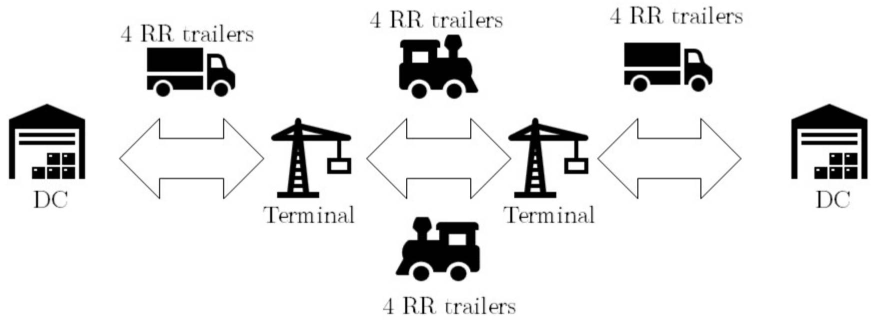


FIGURE 7.15: *16 RailRunner trailers in DC-to-terminal system*

**Row 6 (Average payload of RailRunner trailer (tons)):** The maximum allowable weight of a tri-axle trailer is just over 28 tonnes (TruckScience, 2021). The RailRunner trailers are roughly 5 tonnes heavier than regular trailers. This limits the carrying capacity of the RailRunner trailers to a maximum of 24 tonnes. Therefore, it would be advantageous to use the RailRunner system to transport lightweight freight.

**Row 7 (Average payload of regular trailer (tons)):** Subject matter experts suggest that the average weight of a load on a 7-axle superlink vehicle can range from 32 to 36 tonnes. Furthermore, the weight of a load on a 6-axle vehicle can range from 24 to 28 tonnes.

**Row 8 (Total average payload (tons)):** This is equal to the average payload of one regular trailer for the DC-to-DC methods. For the catching-your-own-pass method this is the average payload of one regular trailer plus the average payload of all the RailRunner trailers in the system.

The DC-to-terminal method can be seen as transporting [number of RailRunner trailers in the system / number of days to transport the trailers] trailers every day, or it can be seen as transporting [number of RailRunner trailers in the system] trailers every [days to make one trip] days. This will yield the same number of trailers transported per annum. The latter way of thinking is used in the financial model to simplify calculations.

**Row 9 (Deck length):** The deck length of a superlink trailer is 18,17 metres (Braun, 2019) and RailRunner South Africa states that the deck length of a RailRunner trailer is 13,65 metres.

**Row 10 (Days to make one trip):** Subject matter experts say that 2 days for a trip on the Capecor for DC-to-DC transport is a reasonable average. RailRunner South Africa states that their goal is for transport involving RailRunner technology to be one day slower than road transport.

**Row 11 (Working days):** This could range from 260 days a year (for a five-day work week) to 365 days a year (for a seven-day work week). Subject matter experts state that a value of 286 for a 5,5-day work week is a good average for South African long-haul trucking.

**Row 12 (Number of trips made):** The number of trips made is the number of working days divided by the number of days to make one trip.

**Row 13 (Average distance travelled in one trip by regular trailer (km)):** This is the distance between the two DCs plus some distance to reposition empty trailers to other DCs to pick up new loads.

**Row 14 (Km per annum (regular trailer)):** This is the average distance travelled in one trip by a regular trailer multiplied by the number of trips made in one year.

**Row 15 (Average distance travelled in one trip by RailRunner trailer on road (km)):** This is the sum of the distance between DC and terminal at the origin and destination.

**Row 16 (Km per annum (RailRunner trailer) on road):** This is the average distance travelled in one trip by a RailRunner trailer on road multiplied by the number of trips made in one year.

**Row 17 (Average distance travelled in one trip by RailRunner trailer on rail (km)):** This is the distance by rail between the origin terminal and destination terminal.

TABLE 7.7: *Financial model: Assumptions continued*

| A | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|
| 3 | | Transport method | DC to DC (super link) | DC to DC (tri-axle) | Catching your own pass | DC to Terminal (2 primary movers) | |
| 18 | | **Km per annum (RR trailer) on rail** | NA | NA | **F17* F12** | **G17* G12** | |
| 19 | | Average distance travelled in one trip by primary mover(s) (km) | D13 | E13 | **F13+2 *F15*F5** | **2*G15 *G5** | |
| 20 | | **Km per annum (primary mover)** | **D12* D19** | **E12* E19** | **F12* F19** | **G12*G19** | >8% |
| 21 | | **tonne-km regular freight** | **D8* D14** | **E8* E14** | **F14* F7** | NA | |
| 22 | | **tonne-km RR freight** | NA | NA | **(F18+ F16)*F6** | **(G18+ G16)*G6** | |
| 23 | | **Total tonne-km** | **D21** | **E21** | **F21+ F22*F5** | **G22*G5** | |

**Row 18 (Km per annum (RailRunner trailer) on rail):** This is the average distance travelled in one trip by a RailRunner trailer on rail multiplied by the number of trips made in one year.

**Row 19 (Average distance travelled in one trip by primary mover (km)):** These values are based on the definition of a trip as described in Section 7.6.1. For the DC-to-DC method the distance is equal to the distance that the regular trailer travels in one trip. For the catching-your-own-pass method, the distance that the primary mover moves is the distance that the regular trailer travels in a trip plus the average distance that the combined RailRunner trailers move on road in one trip multiplied by two, to account for some empty back-haul when the primary mover is moving without a trailer. Similarly, the DC-to-terminal method uses the average distance that the combined RailRunner trailers move in one trip on road multiplied by two, to account for some empty back-haul when the primary mover is moving without a trailer.

**Row 20 (Km per annum (primary mover)):** For DC-to-DC methods the average distance travelled in one trip by a primary mover multiplied by the number of trips made per annum. Some subject matter experts state that this value should be over 210 000 km. This would result from a 5,5-day work week (286 workdays a year) on the Capecor with an average trip time of two days. Other subject matter experts such as Braun (2019) say that this number could be as low as 180 000 km per annum.

For methods involving RailRunner technology, the distance travelled per annum would be less than DC-to-DC methods. This is because the methods involving RailRunner involve short haul movements on city streets where the primary movers cannot move as fast as on highways.

**Row 21 (tonne-km regular freight):** The weight in tonnes of the average load on a regular trailer multiplied by the distance in km that the regular trailer travels per annum.

**Row 22 (tonne-km RailRunner freight):** The weight in tonnes of the average load on a RailRunner trailer multiplied by the distance in km that the RailRunner trailer travels on road and rail per annum. This is calculated for one RailRunner trailer only.

**Row 23 (Total tonne-km):** The tonne-km of the regular trailers plus the tonne-km of all the RailRunner trailers combined.

### Capital cost

The second section of the financial model calculates the total capital cost of all the equipment used. Table 7.8 shows the variables and formulas used.

TABLE 7.8: *Financial model: Capital cost*

| A | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|
| 3 | | Transport method | DC to DC (super link) | DC to DC (tri-axle) | Catching your own pass | DC to Terminal (2 primary movers) | |
| 24 | **CAPITAL COST** | | | | | | |
| 25 | | Primary Mover | | D25 | D25 | 2*D25 | **>2%** |
| 26 | | Auxiliary equipment | | | E26 | E26 | |
| 27 | | Cost of RR trailer | NA | NA | | F27 | **>2%** |
| 28 | | **Total cost of RR trailers** | NA | NA | **F27*F5** | **G27*G5** | |
| 29 | | Regular Trailer | | | E29 | NA | |
| 30 | | Other | | D30 | D30 | D30 | |
| 31 | | **TOTAL CAPITAL COST** | **D30 +D29 +D26 +D25** | **E30 +E29 +E26 +E25** | **F30+ F29+ F28+ F26+ F25** | **G30+ G28+ G26+ G25** | |

**Row 25 (Primary mover):** This is the cost of the primary mover. Take note that there are two primary movers in the DC-to-terminal method. Subject matter experts state that the price of primary mover could be about R1,3 to R1,5 million after negotiation if multiple trucks are bought at once. Large companies that have the necessary capital to invest in many trucks could be able to negotiate these prices. If a small company were to purchase one or two trucks, they would be likely to pay around R1,9 million per primary mover .

**Row 26 (Auxiliary equipment):** Cost of any auxiliary equipment such as underslung diesel generators for refrigerated trailers/containers.

**Row 27 (Cost of a RailRunner trailer):** RailRunner South Africa stated that the price would be around R700 000 for RailRunner trailers.

**Row 28 (Total cost of RailRunner trailers):** The combined cost of all the RailRunner trailers in the system.

**Row 29 (Regular trailer):** The cost of a regular trailer. This price can be negotiated by large companies if many trailers are purchased. This value could then be around R500 000 for a superlink trailer and R400 000 for a tri-axle trailer. Otherwise, the cost is around R600 000 for a superlink trailer and R500 000 for a tri-axle trailer.

**Row 30 (Other costs):** This refers to any other capital costs that may not fall under the categories above.

**Row 31 (Total capital cost):** The sum of the primary movers, auxiliary equipment, trailers, and other equipment.

### Standing cost

The third section of the financial model calculates the total standing cost of the transport methods. Tables 7.9, 7.10, 7.11 and 7.12 show the variables and formulas used.

**Row 33-36 (Depreciation of equipment (over number of years)):** The number of years that the various equipment depreciates over. Braun (2019) states that trucks depreciate at least 20% per annum. This is equivalent to depreciating to a value of zero over five years. Furthermore, they state that auxiliary equipment depreciates over four years and trailers depreciate over ten years.

**Row 37-42 (Depreciation of equipment):** The annual depreciation of each item of equipment. This is calculated as the value of the item divided by the number of years that it depreciates over. These calculations assume no residual value.

**Row 43 (Interest rate):** The interest rate charged on the capital owned.

**Row 44-48 (Interest paid in years 1-5):** This is calculated as the total cost of capital minus the depreciation of capital up until that year. This is then multiplied by the interest rate.

**Row 49 (Cost of capital (average interest paid over 5 years)):** This is the average interest paid over five years.

**Row 50-54 (Licence fees):** This is the licence fees for the primary movers and the trailers. Braun (2019) states that the licencing fees should be R17 280 for a 7-axle superlink trailer and R8 472 for a tri-axle trailer. RailRunner South Africa states that the licence fee for a RailRunner trailer is the same as a regular tri-axle trailer.

**Row 55-56 (Insurance cost):** This is the total insurance cost calculated as a percentage of the total capital cost. 7% is a good estimate to use if unsure of the actual figure.

TABLE 7.9: *Financial model: Standing cost (depreciation)*

| A | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|
| 3 | | Transport method | DC to DC (super link) | DC to DC (tri-axle) | Catching your own pass | DC to Terminal (2 primary movers) | |
| 32 | **STANDING COST** | | | | | | |
| 33 | Depreciation | Primary mover (over number of years) | | D33 | D33 | D33 | |
| 34 | | Auxiliary (over number of years) | | D34 | D34 | D34 | |
| 35 | | Regular trailer (over number of years) | | D35 | D35 | D35 | |
| 36 | | RR trailer (over number of years) | NA | NA | D35 | D35 | |
| 37 | | **Primary mover depreciation** | **D25/ D33** | **E25/ E33** | **F25/F33** | **G25/G33** | |
| 38 | | **Auxiliary depreciation** | **D26/ D34** | **E26/ E34** | **F26/F34** | **G26/G34** | |
| 39 | | **RR Trailer depreciation** | NA | NA | **F27/F36** | **G27 /G36** | |
| 40 | | **Total RR trailer depreciation** | NA | NA | **F5*F39** | **G5*G39** | |
| 41 | | **Regular trailer depreciation** | **D29/ D35** | **E29/ E35** | **F29/F35** | NA | |
| 42 | | **Total depreciation** | **D41 +D38 +D37** | **E41 +E38 +E37** | **F41+ F40+ F38+ F37** | **G40+ G38+ G37** | |

Table 7.10: *Financial model: Standing cost (capital cost)*

| A | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|
| 3 | | Transport method | DC to DC (super link) | DC to DC (tri-axle) | Catching your own pass | DC to Terminal (2 primary movers) | |
| 43 | | Interest rate | | | | | |
| 44 | Capital cost | **Interest paid in year 1** | **(D31) *D43** | **(E31) *D43** | **(F31) *D43** | **(G31)* D43** | |
| 45 | | **Interest paid in year 2** | **(D31-D42* 1)* D43** | **(E31-E42* 1)* D43** | **(F31-F42*1)* D43** | **(G31-G42*1)* D43** | |
| 46 | | **Interest paid in year 3** | **(D31-D42 *2)* D43** | **(E31-E42 *2)* D43** | **(F31-F42*2) *D43** | **(G31-G42*2) *D43** | |
| 47 | | **Interest paid in year 4** | **(D31-D42 *3)* D43** | **(E31-E42 *3)* D43** | **(F31-F42*3) *D43** | **(G31-G42*3) *D43** | |
| 48 | | **Interest paid in year 5** | **(D31-D42 *4)* D43** | **(E31-E42 *4)* D43** | **(F31-F42*4) *D43** | **(G31-G42*4) *D43** | |
| 49 | | **Cost of capital (average interest paid over 5 years)** | **AVERAGE (D44: D48)** | **AVERAGE (E44: E48)** | **AVERAGE (F44:F48)** | **AVERAGE (G44:G48)** | |

TABLE 7.11: *Financial model: Standing cost (licences, insurance and wages)*

| A | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|
| 3 | | Transport method | DC to DC (super link) | DC to DC (tri-axle) | Catching your own pass | DC to Terminal (2 primary movers) | |
| 50 | | Primary mover licence | | D50 | D50 | D50*2 | |
| 51 | | RR trailer licence | NA | NA | E53 | E53 | |
| 52 | Licence | **Total RR trailer licence cost** | NA | NA | **F5*F51** | **G5*G51** | |
| 53 | | Regular trailer licence | | | E53 | NA | |
| 54 | | **Total licence fee** | **D53+ D50** | **E53+ E50** | **F53+F52 +F50** | **G52+G50** | |
| 55 | Insurance | Insurance % of total capital cost | | | | | |
| 56 | | **Total insurance** | **D31* D55** | **E31* D55** | **F31* D55** | **G31* D55** | |
| 57 | | Driver wages per month | | D57 | D57 | D57*2 | |
| 58 | | Driver bonus/overtime | | | | | |
| 59 | Wages | **Driver wages per annum** | **(D57+ D58)* 12** | **(E57+ E58)* 12** | **(F57+ F58)* 12** | **(G57+ G58) *12** | |
| 60 | | Assistant wages per month | | D60 | D60 | D60*2 | |
| 61 | | **Assistant wages per annum** | **D60* 12** | **E60* 12** | **F60*12** | **G60*12** | |
| 62 | | **Total wages** | **D61+ D59** | **E61+ E59** | **F61+F59** | **G61+G59** | >2% |

**Row 57-62 (Wages):** These are the wages of the drivers and driver assistants. Note that the DC-to-terminal method involves two primary movers and therefore requires twice the amount of wages.

Lower wages may be applicable to the DC-to-terminal method because it involves shorter transport distances. Truck drivers that operate on longer routes receive higher pay because they often do not get to sleep at home and are exposed to a higher risk of accidents and theft. The interviewee suggested a value of R22 000 per month (as opposed to the R28 000 suggested by Braun (2019)) for short haul drivers. This would amount to R44 000 in the financial model due to the involvement of two drivers in the DC-to-terminal method.

TABLE 7.12: *Financial model: Standing cost (summary)*

| A | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|
| 3 | | Transport method | DC to DC (super link) | DC to DC (tri-axle) | Catching your own pass | DC to Terminal (2 primary movers) | |
| 63 | | **TOTAL STANDING COST** | **D42+ D49+ D54+ D56+ D62** | **E42+ E49+ E54+ E56+ E62** | **F42+ F49+ F54+ F56+ F62** | **G42+ G49+ G54+ G56+ G62** | **>2%** |
| 64 | | **As a % of total operating cost** | **D63/ D112** | **E63/ E112** | **F63/ F112** | **G63/ G112** | |

**Row 63 (Total standing costs):** This is the sum of the total depreciation, capital cost, licence fees, insurance cost and wages.

**Row 64 (Standing cost as a percentage of total operating cost):** This is the total standing cost divided by the total operating costs (calculated in row 110).

### Variable cost

The fourth section of the financial model calculates the total variable cost of the transport methods. Tables 7.13, 7.14, 7.15 and 7.16 show the variables and formulas used.

**Row 67-70 (Primary mover fuel):** This is the cost of the fuel that the primary mover uses based on the price of fuel, the distance travelled per annum by the primary movers, and the fuel economy of the primary mover. Trucks have lower fuel usage when on the highway compared to on city streets. Therefore, a reduction of fuel economy of about 0,1 and 0,2 km/l for the catching-your-own-pass and DC-to-terminal transport methods can be considered, respectively. The values suggested by subject matter experts for this variable range from 1,9 to 2,2 km/l.

**Row 71-74 (Auxiliary fuel):** This is the cost of the fuel that the auxiliary equipment uses based on the price of fuel, the hours spent operating per annum, and the litres used per hour.

**Row 75-76 (Total fuel):** This is the total fuel used and the cost thereof. It must be noted that the DC-to-DC transport methods are more severely affected by fluctuations in fuel price than transport methods involving the RailRunner system.

**Row 77-78 (Oil used):** This is the cost of oil used calculated as 5% of the total cost of fuel used.

TABLE 7.13: *Financial model: Variable cost (fuel and oil)*

| A | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|
| 3 | | Transport method | DC to DC (super link) | DC to DC (tri-axle) | Catching your own pass | DC to Terminal (2 primary movers) | |
| 65 | **VARIABLE COST** | | | | | | |
| 66 | Fuel | Diesel price: | | | | | >8% |
| 67 | | km/litre (primary mover) | | D67 | D67 | D67 | >8% |
| 68 | | **L/100-km (primary mover)** | **100/ D67** | **100/ E67** | **100/ F67** | **100/ G67** | |
| 69 | | **Total primary mover litres** | **D20/ D67** | **E20/ E67** | **F20/F67** | **G20/G67** | |
| 70 | | **Cost (primary mover)** | **D69* D66** | **E69* D66** | **F69* D66** | **G69* D66** | |
| 71 | | L/Hr (Auxiliary) | | D71 | D71 | D71 | |
| 72 | | Hours per annum (Auxiliary) | | D72 | D72 | D72 | |
| 73 | | **Total Auxiliary Litres** | **D72* D71** | **E72* E71** | **F72* F71** | **G72* G71** | |
| 74 | | **Cost (Auxiliary)** | **D73* D66** | **E73* D66** | **F73* D66** | **G73* D66** | |
| 75 | | **Total Litres** | **D69+ D73** | **E69+ E73** | **F69+ F73** | **G69+ G73** | |
| 76 | | **Total Fuel (rand)** | **D75* D66** | **E75* D66** | **F75* D66** | **2*G75* D66** | >8% |
| 77 | Oil | Top up oil % of total vehicle fuel cost | | | | | |
| 78 | | **Top-up oil** | **D76* D77** | **E76* D77** | **F76* D77** | **G76* D77** | |

TABLE 7.14: *Financial model: Variable cost (maintenance)*

| A | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|
| 3 | | Transport method | DC to DC (super link) | DC to DC (tri-axle) | Catching your own pass | DC to Terminal (2 primary movers) | |
| 79 | Maintenance | Primary mover maintenance (R/km) | | D79 | D79 | D79 | **>2%** |
| 80 | | Auxiliary maintenance (R/hr) | | D80 | D80 | D80 | |
| 81 | | Regular trailer maintenance (R/km) | | | E81 | NA | |
| 82 | | RR trailer maintenance (R/km) | NA | NA | | F82 | |
| 83 | | **Primary mover repair & maintenance** | **D79* D20** | **E79* E20** | **F79* F20** | **G79* G20*2** | |
| 84 | | **Auxiliary repair & maintenance** | **D80* D72** | **E80* E72** | **F80* F72** | **G80* G72** | |
| 85 | | **RR trailer repair & maintenance** | NA | NA | **F82*F16** | **G82*G16** | |
| 86 | | **Total RR Trailer repair & maintenance** | NA | NA | **F5*F85** | **G5*G85** | |
| 87 | | **Regular trailer repair & maintenance** | **D81* D20** | **E81* E20** | **F81* F14** | NA | |
| 88 | | **Total repair & maintenance** | **D87+ D84+ D83** | **E87+ E84+ E83** | **F87+ F84+ F83+ F86** | **G84+ G83+ G86** | **>2%** |

**Row 79-88 (Maintenance):** Maintenance costs are based on the cost per km or the cost per hour of moving or running equipment, respectively. The distance travelled per annum on road is used to calculate the maintenance cost for primary movers and trailers, and the hours run per annum is used for auxiliary equipment. R1,78 per km is a good estimate for the maintenance of primary movers and R1 per km is a good estimate for trailers.

TABLE 7.15: *Financial model: Variable cost (tyres)*

| A | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|
| 3 | | Transport method | DC to DC (super link) | DC to DC (tri-axle) | Catching your own pass | DC to Terminal (2 primary movers) | |
| 89 | Tyres (new) | Number fitted | | | (E89/22) *(10+12 *(1+F5)) | (E89/22) *(10+12 *G5) | |
| 90 | Tyres (new) | **Number used** | **(D93/ D91)* D89** | **(E93/ E91)* E89** | **(F93/ F91)* F89** | **(G93/ G91)* G89** | |
| 91 | Tyres (new) | Km expected | | D91 | D91 | D91 | |
| 92 | Tyres (new) | Price new | | D92 | D92 | D92 | |
| 93 | Tyres (new) | **Km per annum of wheels** | **D20** | **E20** | **F16*F5 +F14** | **G5*G16** | |
| 94 | Tyres (new) | **Total cost of new tyres** | **D92* D90** | **E92* E90** | **F92*F90** | **G92*G90** | |
| 95 | Tyres (re-treads) | Number fitted | | | (E95/22) *(10+12 *(1+F5)) | (E95/22) *(10+12 *G5) | |
| 96 | Tyres (re-treads) | **Number used** | **(D93/ D97)* D95** | **(E93/ E97)* E95** | **(F93/ F97)* F95** | **(G93/ G97)* G95** | |
| 97 | Tyres (re-treads) | Km expected | | D97 | D97 | D97 | |
| 98 | Tyres (re-treads) | Price retread | | D98 | D98 | D98 | |
| 99 | Tyres (re-treads) | **Total cost of retreads** | **D98* D96** | **E98* E96** | **F98* F96** | **G98*G96** | |
| 100 | | **Total tyres** | **D94+ D99** | **E94+ E99** | **F94+ F99** | **G94+ G99** | |

**Row 89 (Number of new tyres fitted):** The total number of tyres fitted to a 7-axle and 6-axle truck is 26 and 24, respectively. Some of these tyres are new and some are retreads. To calculate the number of new tyres needed for the catching-your-own-pass and DC-to-terminal methods the ratio of new tyres to total tyres fitted must first be calculated. This is then multiplied by the total number of tyres on the primary mover and trailers used in each method.

**Row 90 (Number of new tyres used):** This is the km per annum travelled by the wheels divided by the distance in km expected of each tyre. This value is then multiplied by the number of new tyres fitted.

**Row 91 (Km expected):** The distance in km that the tyres are expected to last. This is about 120 000 km for new tyres.

**Row 92 (Price of new tyres):** This is the price of one new tyre. These prices vary widely. A price of R8 300 per tyre can be used if one is unsure of the actual price.

**Row 93 (km per annum of wheels):** This is the distance that the tyres travel in km per annum. In the DC-to-DC method the distance is equal to the distance that the primary mover moves. In the catching-your-own-pass and DC-to-terminal method the total distance that all the trailers in the system travel on road is used. This does not consider the distance that the tyres on the primary mover move or the differences in the distances that the tyres move on RailRunner trailers or regular trailers. To accurately calculate the values in detail would however greatly complicate the model, and since the cost of tyres has a very small influence in the cost per tonne-km, these simplified calculations are used.

**Row 94 (Total cost of new tyres):** This is the price of new tyres multiplied by the number of new tyres used.

**Row 95 (Number of retreads fitted):** The total number of tyres fitted to a 7-axle and 6-axle truck is 26 and 24, respectively. Some of these tyres are new and some are retreads. To calculate the number of retreaded tyres needed for the catching-your-own-pass and DC-to-terminal methods the ratio of retreaded tyres to total tyres fitted must first be calculated. This is then multiplied by the total number of tyres on the primary mover and trailers used in each method.

**Row 96 (Number of retreaded tyres used):** This is the km per annum travelled by the wheels divided by the distance in km expected of each tyre. This value is then multiplied by the number of retreaded tyres fitted.

**Row 97 (Km expected):** This is the distance in km that the tyres are expected to last. This is about 120 000 km for retreaded tyres.

**Row 98 (Price of retreaded tyres):** This is the price of one retreaded tyre. These prices vary widely. A price of R3 400 per retreaded tyre can be used if one is unsure of the actual price.

**Row 99 (Total cost of retreaded tyres):** This is the price of retreaded tyres multiplied by the number of retreaded tyres used.

**Row 100 (Total cost of tyres):** This the combined cost of all the new and retreaded tyres.

**Row 101 (Cost per tonne-km charged for a RailRunner trailer on rail):** This is the cost that RailRunner South Africa will charge LSPs to move their RailRunner trailers on rail. This is charged per tonne-km which is the industry standard unit of measurement for freight transport on rail. RailRunner South Africa is still undecided on the fee that they will charge but a cost of R0.30 per tonne-km is the value that they have suggested for now. Some subject matter experts say that this is an extremely competitive rate. They say that this price will be difficult to get outside of South Africa.

**Row 102 (Cost to move RR trailer(s) over rail):** This is the cost per tonne-km multiplied by the tonne-km that is moved by the RailRunner trailers on rail.

**Row 103 (Terminal handling cost):** This is the cost of handling one RailRunner trailer at the origin and destination terminal. Currently, this value is included in the cost per tonne-km, but it was left in, in case this were to change.

**Row 104 (Total terminal handling cost):** The cost of handling all the RailRunner trailers in a year.

TABLE 7.16: *Financial model: Variable cost (rail cost, tolls, and summary)*

| A | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|
| 3 | | Transport method | DC to DC (super link) | DC to DC (tri-axle) | Catching your own pass | DC to Terminal (2 primary movers) | |
| 101 | Rail cost | Cost per tonne-km charged for RR trailer on rail | NA | NA | | F101 | >8% |
| 102 | | **Cost to move RR trailer(s) over rail** | NA | NA | **F101*F6 *F18*F5** | **G101*G6 *G18*G5** | >8% |
| 103 | | Terminal handling cost | NA | NA | | F103 | |
| 104 | | **Total terminal handling cost** | NA | NA | **F103* F12*F5** | **G103* G12*G5** | |
| 105 | Tolls | Toll fees per trip | | | E105 | NA | |
| 106 | | **Toll fees per annum** | **D105* D12** | **E105* E12** | **F105* F12** | NA | |
| 107 | | Unforeseen expenses | | | | F107 | |
| 108 | | **TOTAL VARIABLE COST** | **D76+ D78+ D88+ D100+ D107+ D106** | **E76+ E78+ E88+ E100+ E107+ E106** | **F76+ F78+ F88+ F100+ F107+ F102+ F104** | **G76+ G78+ G88+ G100+ G107+ G102+ G104** | >8% |
| 109 | | **As a % of total operating cost** | **D108/ D110** | **E108/ E110** | **F108/ F110** | **G108/ G110** | |
| 110 | | **TOTAL OPERATING COSTS** | **D63+ D108** | **E63+ E108** | **F63+ F108** | **G63+ G108** | |

**Row 105-106 (Tolls):** The cost of toll fees for the primary mover moving regular trailers . A total cost of R826 would be charged on a trip on the Capecor according to TruckScience (2021).

**Row 107 (Unforeseen expense):** Any expenses that may not be evident beforehand. Braun (2019) suggests that this value should be R125 000, and RailRunner South Africa suggests that it should be slightly more, with a value of R300 000.

**Row 108 (Total variable cost):** This is the sum of the cost of fuel, oil, repair and maintenance, tyres, tolls and rail costs.

**Row 109 (Variable cost as a percentage of total operating cost):** This is the total variable cost divided by the total operating costs (calculated below).

**Row 110 (Total operating costs):** This is the total standing costs plus the total variable cost.

### Comparison summary

The fifth section of the financial model calculates the comparison summary of the transport methods. Tables 7.17 and 7.18 show the variables and formulas used. These values can be used to see which transport methods perform better in terms of cost.

**Row 112 (Standing cost (rand/day)):** The total standing cost divided by the number of working days per annum.

**Row 113 (Standing cost (rand/km)):** The total standing cost divided by the km travelled per annum.

**Row 114 (Variable cost (rand/km)):** The total variable cost divided by the km travelled per annum.

**Row 115 (Cost per tonne (rand)):** The total operating cost divided by the total tonnes moved per annum.

**Row 116-118 (Cost per tonne-km (100%-50% load)):** The total operating cost divided by a percentage of the tonne-km.

**Row 119 (Cost per deck metre):** The total operating cost divided by the deck length multiplied by the number of trips made.

**Row 120 (Total cost per km (rand/km)):** The total operating cost divided by the km travelled per annum. This is the industry standard unit of measurement for transport rates in the road freight industry. Subject matter experts say that this value should be between R14 and R16 per km.

**Row 121-122 (Cost per tonne-km):** This is the cost per tonne-km based on a load percentage defined by the user.

**Row 123 (Percentage of DC-to-DC method):** This is the cost per tonne-km of the catching-your-own-pass and DC-to-terminal methods compared to the 6-axle DC-to-DC method.

**Row 124 (Percentage of DC-to-DC method (superlink)):** This is the cost per tonne-km of the catching-your-own-pass and DC-to-terminal methods compared to the 7-axle superlink DC-to-DC method.

**Row 125 (Cost per trailer per trip):** This is the cost of moving one trailer in one trip. Subject matter experts state that a good average cost for a 7-axle superlink is R24 000 for one trip on the Capecor.

TABLE 7.17: *Financial model: Comparison summary*

| A | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|
| 3 | | Transport method | DC to DC (super link) | DC to DC (tri-axle) | Catching your own pass | DC to Terminal (2 primary movers) | |
| 111 | **Summary** | | | | | | |
| 112 | Other costs | **Standing cost rand per/day** | **D63/ D11** | **E63/ E11** | **F63/ F11** | **G63/ G11** | |
| 113 | | **Standing cost (rand/km)** | **D63/ D20** | **E63/ E20** | NA | NA | |
| 114 | | **Variable cost (rand/km)** | **D108/ D20** | **E108/ E20** | NA | NA | |
| 115 | | **Cost per tonne (rand)** | **D110/ (D8 *D12)** | **E110/ (E8 *E12)** | **F110/ (F8*F12)** | **G110/ (G8*G12)** | |
| 116 | | **Cost per tonne-km (100% load)** | **D110/ (D21)** | **E110/ (E23)** | **F110/ (F23)** | **G110/ (G23)** | |
| 117 | | **Cost per tonne-km (75% load)** | **D110/ (D21* 0.75)** | **E110/ (E23* 0.75)** | **F110/ (F23* 0.75)** | **G110/ (G23* 0.75)** | |
| 118 | | **Cost per tonne-km (50% load)** | **D110/ (D21* 0.5)** | **E110/ (E23* 0.5)** | **F110/ (F23* 0.5)** | **G110/ (G23* 0.5)** | |
| 119 | | **Cost per deck metre (100%)** | **D110/ (D12 *D9)** | **E110/ (E12 *E9)** | **F110/ (F12*F9 *(F51))** | **G110/ (G12* G9*G5)** | |
| 120 | | **Total cost per km (rand/km)** | **D110/ D20** | **E110/ E20** | NA | NA | |

TABLE 7.18: *Financial model: Comparison summary continued*

| A | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|
| 3 | | Transport method | DC to DC (super link) | DC to DC (tri-axle) | Catching your own pass | DC to Terminal (2 primary movers) | |
| 121 | | % load | | D121 | D121 | D121 | |
| 122 | | **Cost per tonne-km** | **D110/ (D21* D121)** | **E110/ (E23* E121)** | **F110/ (F23* F121)** | **G110/ (G23* G121)** | |
| 123 | | **Percentage of DC to DC method** | NA | **E122/ E122** | **F122/ E122** | **G122/ E122** | |
| 124 | | **Percentage of DC to DC method (superlink)** | **D122/ D122** | NA | **F122/ D122** | **G122/ D122** | |
| 125 | | **Cost per trailer per trip** | **D110/ D12** | **E110/ E12** | **(F110/ F12)/ (F5+1)** | **(G110/ G12)/ (G5)** | |
| 126 | | **Percentage of DC to DC method** | NA | **E125/ E125** | **F125/ E125** | **G125/ E125** | |
| 127 | | **Percentage of DC to DC method (superlink)** | **D125/ D125** | NA | **F125/ D125** | **G125/ D125** | |

**Row 126 (Percentage of DC-to-DC method):** This is the cost per trailer per trip of the catching-your-own-pass and DC-to-terminal methods compared to the 6-axle DC-to-DC method.

**Row 127 (Percentage of DC-to-DC method (superlink)):** This is the cost per trailer per trip of the catching-your-own-pass and DC-to-terminal methods compared to the 7-axle superlink DC-to-DC method.

## 7.7 Decision matrix

When considering the use of different methods of transport, LSPs look at multiple aspects of transport. These aspects include cost, reliability, speed etc. These aspects can be used to measure the performance of each transport method. The best way to do this is by using a decision matrix. This section discusses a proposed decision matrix that uses all the necessary aspects of transport to compare the methods of transport mentioned in the financial model in Section 7.6. This matrix can be used by an LSP to quantify and visualise their attitudes towards these methods.

### 7.7.1 Structure

The following methods of transport are used in the decision matrix:

- DC-to-DC (7-axle vehicle with a superlink trailer);

- DC-to-DC (6-axle vehicle with a regular tri-axle trailer);
- Catching your own pass (Uses one regular trailer and one or more RailRunner trailers);
- DC-terminal (Uses multiple RailRunner trailers only).

Table 7.19 shows an example of a decision matrix. Each aspect of transport is listed and assigned a weight of importance by the user. The following definitions apply to the aspects of transport:

- **Reliability**: The ability of the LSP to meet contractual agreements;
- **Time/punctuality**: The time that it takes the freight to be transported and the accuracy of estimated times of arrival;
- **Frequency of services**: The frequency of services that are available (Example: one train a day);
- **Cost of investment**: The cost of investing in RailRunner trailers;
- **Cost per tonne-km**: The cost per tonne-km of the transport;
- **Flexibility**: The ability to adapt to the changing of a freight-owners' needs;
- **Safety/security**: Number of accidents, loss of freight, theft etc.;
- **Environment**: GHG emissions, fuel usage, noise pollution etc.;
- **Tracking (communication)**: The ability to track and communicate the location of freight to the freight owner;
- **Durability**: The longevity of the mode of transport. For example, a trailer will not last as long if it travels poorly maintained roads;
- **Political stability**: The political stability of the area that the transport is moving through. Political unrest could affect the profitability of freight transport;
- **Financial stability**: The financial stability of the regions that the freight originates from. This may be a concern for cross-border travel where exchange rates may affect the profitability of freight transport.

The weights of the aspects of transport are defined as follows:

5: Critical

4: Important

3: Somewhat

2: Unimportant

1: Trivial

0: Irrelevant

TABLE 7.19: *Decision matrix example*

| | | | Transport systems | | | |
|---|---|---|---|---|---|---|
| | | Weight | DC-to-DC superlink | DC-to-DC 6 axle artic | Catching your own pass | DC-to-Terminal |
| Aspects of transport | Reliability | 4 | 1 | 1 | 0 | 0 |
| | Speed or punctuality | 4 | 1 | 1 | 0 | 0 |
| | Frequency of services | 4 | 1 | 1 | 0 | 0 |
| | Cost (Investment) | 1 | 0 | 0 | 0 | 0 |
| | Cost (tonne-km ) | 5 | 0 | 0 | 0 | 1 |
| | Flexibility | 2 | 1 | 1 | 0 | 0 |
| | Safety/security | 3 | 1 | 1 | 0 | 0 |
| | Environment | 3 | 0 | 0 | 1 | 1 |
| | Tracking (communication) | 5 | 0 | 0 | 1 | 1 |
| | Durability | 0 | 0 | 0 | 1 | 1 |
| | Political stability | 0 | 1 | 1 | 0 | 0 |
| | Financial stability | 0 | 1 | 1 | 0 | 0 |
| | Total | 31 | 7 | 7 | 3 | 4 |
| | Weighted total | | 30 | 30 | 13 | 17 |

The four different methods of transport are listed in the top row. Each method of transport can perform better or worse than other methods according to a binary scale of zero to one. Some methods may outperform others depending on which aspect is being looked at. The ones and zeroes represent the following:

1: Performs just as well as other systems with a value of 1;

0: Performs worse than other systems with a value of 1.

When the weights and performance values are inserted in the table, a weighted total can be calculated to be able to gauge the attitude of the user of this toolkit toward the use of RailRunner transport methods for a specific customer and route application. The decision matrix can also be used to see what aspects have the greatest influence on the weighted total of certain methods.

### 7.7.2 Recommendations

This section takes an in-depth look at the aspects of transport in the decision matrix and makes some recommendations.

**Reliability:**

Some subject matter experts stated that they find the questionable reliability of Transnet Freight Rail (South Africa's state-owned rail transport company) to be a major drawback of the RailRunner system. They expressed their doubts in the transport time of one extra day for RailRunner transport compared to road transport. They also stated that the maintenance of rail infrastructure in South Africa has been neglected in past years, and an unattainable amount of capital is needed to restore everything to working order. Subject matter experts pointed out that poor reliability may negatively impact the precise scheduling of DCs. It is because of these reasons that most subject matter experts say that they would want to see the success of the system before they decide to invest in RailRunner trailers.

**Time/punctuality:**

Transport time would be critical for commodities such as FMCG and refrigerated goods. Goods such as FMCG rely on short lead times between when demand is experienced, to when supply is provided, to avoid loss of money. Goods that are subject to rapid ageing also require fast transport times to avoid deterioration in quality.

**Frequency of services:**

Like the speed of transport, freight requiring a short lead time would also require frequent services, so that freight can be transported whenever necessary.

**Cost of investment:**

Large companies with contracts to move large volumes of freight would not consider the cost of investment to be important. LSPs would, however, need to be certain of a large volume of freight that can be transported using the RailRunner system before they invest in the RailRunner trailers. These companies, as mentioned before, would want to see that the system is working prior to investing in multiple trailers at once.

Smaller companies may find it more difficult to invest in expensive RailRunner trailers. This is not only due to lack of capital and hindrances in cash flow, but also to the fact that it may complicate their operations significantly. This is especially true for the catching-your-own-pass transport method where regular and RailRunner trailers are transported simultaneously.

An advantage that the RailRunner trailers have is that they would last much longer than regular trailers because of the limited distance that they travel on road. The RailRunner trailers incur much less wear and tear on rail than they do on road. The return on investment would therefore eventually be higher for RailRunner trailers.

**Cost per tonne-km:**

Subject matter experts say that the cost of transport would be important in two situations. First, if time-sensitive freight is being transported then the cost per tonne-km would have to make up for the increase in transport time or reduction in reliability. Secondly, the cost per tonne-km is directly proportional to the weight of the freight, so it would have a higher importance for heavier loads. Furthermore, a small reduction in transport cost may be more attractive to larger companies that work with smaller profit margins.

**Flexibility:**

Flexibility would be less important for the transport of large volumes of bulk commodities. The following example can be used to demonstrate this concept. In a situation where 30 000 tonnes of iron ore must be moved over a period of one month, it would not matter if 1 000 tonnes were moved every day, or at other times 2 000 tonnes were moved every other day.

Small high-value loads, however, may need greater flexibility. An example can be used of car parts that need to be delivered urgently so that a production line does not stop.

**Safety/security:**

Safety and security could be an important aspect for high-value goods or for hazardous materials such as liquid fuel. Rail has been shown to be safer than road in terms of transporting hazardous materials. This is due to a lower risk of accidents as well as a reduced risk of endangering people in the vicinity of the accident.

Theft is also a major concern for road as well as rail. Some subject matter experts suggest that the best way to reduce risk of theft on rail is to use RailRunner box trailers that cannot be opened when a RailRunner train is assembled. If the RailRunner system were to be safer than road then LSPs may be able to cut down on insurance costs.

**Environment:**

The environment is becoming a bigger concern to companies around the world. Pressure from the public as well as the future imposition of carbon tax will increase the importance of cutting down on GHG emissions. Rail uses mainly electrical power, so it would be easier for it to switch to renewable sources compared to road transport. Furthermore, the use of electrically powered trucks would be favourable for the short haul distances between DCs and intermodal terminals.

**Tracking (communication):**

Some subject matter experts state that freight owners are aware of the problems that may cause delays, and that they are understanding if delays were to occur. The LSP must be able to communicate the reason for the delay and where the freight is located. Therefore, most LSPs find the ability to track the freight to be incredibly important.

**Durability:**

The durability of equipment may become a crucial factor when travelling over poorly maintained roads. The majority of the RailRunner system involves transport on rail which results in significantly lower wear and tear compared to road. As mentioned before, the longevity of RailRunner trailers results in an eventual better return on investment. This aspect may be important for LSPs operating in harsh road environments.

**Political stability:**

Political unrest is a major concern when travelling across borders. There are a multitude of factors that could hinder the transport of freight in politically unstable nations. Subject matter experts say that this is an important aspect to consider if an LSP is transporting goods through such nations.

**Financial stability:**

Exchange rates, price of fuel, labour costs, etc. can have a major influence on the profit of an LSP. If a large investment is made by an LSP by purchasing multiple RailRunner trailers, and using the RailRunner system, then they need to be sure that the costs involved will remain constant for a long time to come. This aspect is therefore important to LSPs that operate in financially unstable regions.

## 7.8 Frequently asked questions

**Question 1:** Can a superlink trailer be used in the RailRunner system?

**Answer 1:** No, a RailRunner trailer must be one rigid structure with no articulated joint.

**Question 2:** How do refrigerated trailers get power?

**Answer 2:** If necessary, the RailRunner trailers will have an underslung diesel generator and fuel tank capable of six days of uninterrupted cold chain. This generator would be able to supply power whether the trailer is on road or rail. An example of a trailer with an underslung generator can be seen in Figure 7.16.


FIGURE 7.16: *Example of a reefer container on a RailRunner trailer with an underslung diesel generator*

**Question 3:** Can regular trailers be converted into RailRunner trailer?

**Answer 3:** RailRunner South Africa states that it would be more expensive to convert an existing trailer to be able to work in the RailRunner system that it would be to trade in that trailer for a RailRunner trailer and pay in the remaining difference.

**Question 4:** Can RailRunner trailers be sold off to the North American market?

**Answer 4:** RailRunner South Africa states that RailRunner North America is always looking for new trailer suppliers.

**Question 5:** How many RailRunner trailers make up one train?

**Answer 5:** 40 to 50 trailers make up one train even though the trailers are built to be able to withstand the forces within a train consisting of 150 trailers.

**Question 6:** Does a train have to be full before it leaves the terminal?

**Answer 6:** No, RailRunner South Africa is committed to running a regular service. Therefore, trains will leave from terminals at regular intervals even if they are not full.

**Question 7:** How long does it take to assemble a RailRunner train?

**Answer 7:** RailRunner South Africa states that they can assemble a train of 40 trailers in four hours with two people, one yard hostler and a forklift. With more resources they could reduce this to one hour.

**Question 8:** Do trains stop operating during load shedding?

**Answer 8:** No. Trains are not affected by load shedding.

## 7.9 Toolkit conclusion

This document provides a set of tools that can be used by LSPs to assess the benefits and drawbacks of using the RailRunner system for their freight transport operations. An accompanying spreadsheet was provided for the tools that required user interaction. These tools are the financial model and the decision matrix. The full set of tools is listed below:

- A section explaining what the RailRunner system/technology is;
- Selection criteria for LSPs that can benefit from the RailRunner system;
- Stakeholder analysis on the role players that may have an interest or influence on the decision to use the RailRunner system;
- A financial model comparing the operating costs of road-only systems with systems involving the RailRunner technology;
- A decision matrix that assists LSPs to quantify and visualise their attitudes towards different transport methods;
- A section on frequently asked questions that helps to clear up any misconceptions of the RailRunner system or technology.

By using these tools, anyone using this toolkit should be able to make an informed decision on the usefulness of using the RailRunner system for any scenario. These scenarios can vary depending on the route taken, resources available, freight owner, commodities transported, stakeholders involved and many other factors.

## 7.10 Chapter conclusion

This chapter achieves research objective four by providing a finalised toolkit. The input process and output of this objective can be seen in Figure 1.8. The next step will be to validate the finalised toolkit in Chapter 8.

CHAPTER 8

# Validation interviews

Contents



## 8.1 Introduction

This chapter discusses the validation of the finalised toolkit as seen in Chapter 7. It aims to achieve research objective five: validating the finalised toolkit (as explained in Figure 1.8). The validation was done by first sending the toolkit to multiple subject matter experts. Secondly, interviews were then done with the subject matter experts to determine the validity and usefulness of the toolkit.

A wide range of experts with experience in various areas of the transport industry were interviewed to provide the most comprehensive answer to the validity and usefulness of the toolkit. Each section in this chapter will discuss the comments and remarks made by the different subject matter experts for every section of the finalised toolkit. Table 8.1 shows a brief description of all the people that were interviewed. The interviewees will be identified by a number as seen in the table.

TABLE 8.1: *Subject matter experts interviewed for validation*

| Interviewee number | Interviewee description |
|---|---|
| 1 | • Currently working as an operational director at a company with over 90 trucks;<br>• Has 24 years' experience in Logistics including 12 years in bulk liquid transport;<br>• Currently transports FMCG and retail goods;<br>• Has experience in road freight only;<br>• Operates all over South Africa and partially across borders;<br>• Specialises in the use of refrigerated and box trailers. |
| 2 | • Currently working as an operations director at a company with over 100 trucks;<br>• Started their own transport company in the 90s and merged with another company in late 2000s;<br>• Currently transports break bulk (20kg to 5 Tonnes), automotive parts, pharmaceutical goods, palletised goods, hardware, general freight, motorcycles, dry goods, etc.;<br>• Has experience in road freight only;<br>• Operates all over South Africa;<br>• Specialises in the use of curtain side trailers. |
| 3 | • Currently working as a transport manager at a company with over 80 trucks;<br>• They have a diploma in maritime studies and worked in imports and exports of wine and specialised goods;<br>• Currently transports FMCG, oil and gas;<br>• Has experience in freight transport via road, rail, air and sea;<br>• Operates all over South Africa;<br>• Specialises in the use of curtain side, flat-bed, box, and refrigerated trailers. |
| 4 | • Currently working as CEO of an LSP with over 90 trucks;<br>• They started off as a truck driver and moved on to sales in the transport industry;<br>• They then started their own LSP;<br>• Currently transports fuel, break bulk and grain;<br>• Has experience in road freight transport and a small amount of experience in rail transport;<br>• Operates all over South Africa ;<br>• Specialises in the use of curtain side, drop side, tipper, and flat deck trailers. |
| 5 | • Has over 40 years' experience in rail logistics and has worked on introducing bimodal technologies in South Africa of more than 20 years.<br>• Operates all over South Africa . |
| 6 | • Currently working as the director of fleet management of an LSP with over 90 trucks;<br>• They have worked in logistics and road transport for over 20 years;<br>• Currently transports retail products, FMCG, automotive parts and raw materials;<br>• Operates all over South Africa and partially across borders;<br>• Specialises in the use of mostly box trailers. |

## 8.2 The RailRunner system/technology

When asked about the section on the RailRunner system and technology, all the interviewees said that the section clearly explained the key information, and nothing was left to interpretation. Any questions that the interviewees had during the interviews on the RailRunner system, technology or company were easily and quickly cleared up once directed to the correct passage in the section.

## 8.3 Selection criteria

All the interviewees stated that the section on selection criteria (Section 7.4) provided a well-defined, and comprehensive list of selection criteria for transport characteristics and commodity types that are suitable for the use of the RailRunner system. The third interviewee stated that it is important to note that frozen goods are not as time-sensitive as refrigerated goods. They stated that goods that must be kept cold, but not below zero degrees Celsius, are more likely to experience rapid ageing as described in criterion B4 in Table 7.4. The first interviewee also stated that the selection criteria helped them to understand that the RailRunner system is not a solution for all types of freight. Lastly, the sixth interviewee stated that it may be difficult to find companies that comply with all the selection criteria.

## 8.4 Stakeholder analysis

All the interviewees said that the stakeholder analysis would help them to identify the right stakeholders and how they should be categorised. The interviewees also agreed with the fact that freight owners have a varying amount of interest and power in what mode of transport is used to transport their freight. They stated that freight owners mostly do not care about what mode is used as long as it is fast, reliable and cheap.

## 8.5 Financial model

All the interviewees said that the values and calculations in the financial model were realistic and that all the necessary variables were considered. The second interviewee said that the cost of R24 000 per trailer per trip may be higher than the average cost. This value (much like all the other values in the model) will, however, vary depending on what LSP is using the model.

A discussion on the financial model was also held with RailRunner South Africa and a member of the RailRunner North America team. They all stated that it was a comprehensive and useful tool that would allow any LSP to see how much money they could save. RailRunner South Africa stated that they would still have to work on providing an answer to the exact cost that they would charge the LSPs to move the RailRunner trailers on rail.

The spreadsheet would be a useful tool for LSPs to develop scenarios for different transport routes, commodities transported and freight owners.

## 8.6 Decision matrix

The interviewees stated that the decision matrix was a useful tool for them to be able to visualise their views on using the RailRunner system. They also stated that all the necessary aspects of transport were listed in the matrix. The second interviewee stated that the matrix helped them to think about everything necessary to make an informed decision.

## 8.7 Frequently asked questions

Any questions that the interviewees had during the interviews were easily cleared up by referring to the section on frequently asked questions.

## 8.8 Final remarks from interviewees

Most interviewees were wary about the use of rail because of the unreliability of Transnet. They stated that they have experienced multiple delays when working with Transnet in the past. They also stated that theft is a major problem when using rail. Most of the delays and theft experienced happened at the terminals. RailRunner South Africa would hopefully be able to mitigate this since they would take over the management of the terminals from Transnet. The second interviewee said that LSPs would make decisions on what they see, so RailRunner South Africa would have to make sure that the system works during the trial on the Capecor.

The third interviewee stated that the use of electrical vehicles would soon become something that should be included in the toolkit. This is especially relevant to the use of short haul trucking seen in the methods of transport that make use of the RailRunner system.

The fifth interviewee advised that a narrower scope may have allowed for fewer but more comprehensive tools in the toolkit. They stated that the toolkit could be seen as, or complementary to, a Strengths Weaknesses Opportunities and Threats (SWOT) analysis. They stated that the deciding factor for LSPs will largely be based on return on investment.

## 8.9 Chapter conclusion

All the subject matter experts interviewed were satisfied with the tools in the toolkit. They stated that all the tools achieved the necessary outcomes. They also stated that the tools were applicable to the decision that LSPs would have to make regarding the use of the RailRunner system. This chapter achieves research objective five by providing a comprehensive answer on the validity and usefulness of the finalised toolkit. The input process and output of this objective can be seen in Figure 1.8.

# CHAPTER 9

# Conclusions and recommendations

Contents



## 9.1 Conclusions

As mentioned in Chapter 1, South Africa would benefit greatly from developing a road-to-rail bimodal solution. It would help to lower the high externality and logistics costs experienced in South Africa. These costs are incurred because of South Africa's reliance on long-distance road transport. A bimodal solution would help to reduce GHG emissions, fuel usage and accidents. Ideally, trucks would do the collection and distribution of freight and rail would be used for the high-density, long-distance transport segment (Van Eeden and Havenga, 2010).

A large scale implementation of a bimodal system would also benefit South Africa's economy. Less maintenance would have to be done on roads and less fuel would have to be imported. RailRunner South Africa states that they would be able to create many job opportunities centred around the manufacturing of RailRunner equipment and management of the RailRunner system.

Empowering RailRunner South Africa would help to make the successful implementation of a bimodal system in South Africa a reality. Therefore, this thesis set out to develop a toolkit that would assist in the decision-making process of LSPs to transition to the use of bimodal transport in South Africa. The focus was put on the RailRunner system and technology since RailRunner South Africa is the only company working on transforming the bimodal transport industry in South Africa at the moment.

This thesis could also be used as a building block for future research on bimodal technology in South Africa which is a topic on which little has been done.

### 9.1.1 Methodology

As seen in Figure 1.11 the introduction established the objectives and methodology. The literature review was written with these objectives in mind. The selection criteria were set up with the use of the literature review and a section on the RailRunner system and technology. The literature review, the section on the RailRunner system and technology, and the selection criteria were all used to set up a preliminary toolkit. This preliminary toolkit was used as an input to construct a structure for exploratory interviews. Each exploratory interview laid the ground for the next exploratory interview as well as adding to the finalised tool kit. The finalised toolkit was then used to conduct validation interviews. Lastly, conclusions and recommendations were discussed while keeping the entire process in mind.

### 9.1.2 Objectives

This thesis set out to achieve five objectives. The following five subsections discuss how each of these objectives was successfully achieved.

#### Objective 1: Literature review

Information from various sources such as Google Scholar, ScienceDirect and Web of Science were used to do a literature study. The sources used were in the form of academic papers, books and articles. The goal of the literature study was to gain a clear understanding of the following topics:

- Bimodal transportation in other countries;
- The road and rail industries in South Africa;
- Characteristics of rail transport;
- Characteristics of road transport;
- Commodity types suitable for bimodal transportation;
- The advantages of moving transport from road-only to bimodal transport;
- The challenges of moving from road-only to bimodal transport;
- The transport criteria/requirements of LSPs and freight owners.

Some of these topics required in-depth, and definitive answers to be able to set up selection criteria and a preliminary toolkit. That is why the literature review has two parts. The first part (thematic literature review as seen in Chapter 2) provides a background to the inland transport industry of South Africa. The second part (structured literature review as seen in Chapter 3) provides definitive answers to the key questions that were identified in the thematic literature review.

The information in these two chapters not only allowed for selection criteria and a preliminary toolkit to be established, but also provided useful context and background to the concepts discussed in the rest of this thesis.

#### Objective 2: Defining selection criteria for potential users

After the literature study was completed, preliminary selection criteria for potential users was set up as explained in Chapter 5. The increased knowledge of topics such as commodity types and transport criteria assisted in assigning greater importance to certain criteria. The characteristics of the RailRunner system also had to be considered when selecting the criteria. Therefore, a further chapter was included after the literature study to explore the RailRunner system and technology (Chapter 4). This chapter provided a useful background to the RailRunner company and the system and technology that they implement.

The criteria not only helped to find subject matter experts that could be interviewed for exploratory and validation interviews, but also for use in the toolkit to assist in identifying potential users of the RailRunner system.

#### Objective 3: Preliminary toolkit

After the knowledge had been gained by conducting the literature review, discussing the RailRunner system, and the selection criteria had been defined, a preliminary toolkit was constructed as shown in Appendix B. This toolkit was then used to conduct the exploratory interviews so that the toolkit could be fleshed out. It also served as a skeletal structure to which information gathered from subject matter experts could be added.

#### Objective 4: Finalised toolkit

Semi-structured exploratory interviews were done to add to and refine the preliminary toolkit discussed in Chapter 6. These interviews built progressively on each other and were therefore not meant to function as validation for the toolkit. The interviews provided an effective way to identify key factors that might not have been evident at first. Once the toolkit (now labelled as the finalised toolkit in Chapter 7) had reached a satisfactory level of completion, then validation interviews began. The finalised toolkit could be sent to subject matter experts as a stand-alone document that they could read through and provide comments on. The toolkit contained the following tools:

- A section explaining what the RailRunner system/technology is (Section 7.3);
- Selection criteria for LSPs that can benefit from the RailRunner system (7.4);
- Stakeholder analysis on the role players that may have an interest or influence on the decision to use the RailRunner system (Section 7.5);
- A financial model comparing the operating costs of road-only systems with systems involving the RailRunner technology (Section 7.6);
- Decision matrix that assists LSPs to quantify and visualise their attitudes towards different transport methods (Section 7.7);
- A section on frequently asked questions that helps to clear up any misconceptions of the RailRunner system or technology (Section 7.8).

**Objective 5: Validation of the finalised toolkit**

Validation interviews were conducted to validate the finalised toolkit as covered in Chapter 8. These interviews involved talking with various subject matter experts about the validity and usefulness of the toolkit. The information gained from the interviews was then collated and summarised.

The toolkit was successfully validated by various subject matter experts that were satisfied with the comprehensiveness and usefulness of the tools in the toolkit. The following list itemises the concluding points made in the validation interviews:

- The selection criteria helped subject matter experts to understand that the RailRunner system is not a one-size-fits-all solution.
- Subject matter experts said that the stakeholder analysis would help them to identify the right stakeholders and how they should be categorised. They also agreed that freight owners have varying amounts of interest and control over what method of transport is used.
- Subject matter experts and members from RailRunner South Africa and RailRunner North America stated that the financial model contained all the necessary variables and calculations.
- The decision matrix contained all the necessary aspects of transport and helped the subject matter experts to visualise their views on the use of transport methods involving road and rail.

Most subject matter experts were wary about the reliability of Transnet. Therefore, RailRunner South Africa would have to make sure that the trial on the Capecor runs smoothly. One subject matter expert stated that the use of electrical vehicles would soon become relevant as another method of transport to be considered in the toolkit.

One subject matter expert said that the toolkit may have benefited from a narrower scope. They said that fewer tools may have allowed for the remaining tools to be more well-rounded. They also noted that the toolkit may be complementary to a SWOT analysis.

## 9.2 Sensitivity of toolkit elements

Some elements in the toolkit and decision matrix had a greater influence on the decision of the subject matter experts to use the RailRunner system. It is, however, difficult to quantify this sensitivity since this thesis focused mainly on qualitative methods. This section discusses these elements.

The aspects of transport that had the greatest influence on the outcome of the decision matrices tended to be the reliability, time/punctuality, frequency of services, cost (tonne-km), security/safety and tracking (communication). This is especially true for goods with short lead times such as FMCG. Although no concrete conclusions can be drawn from the information in Table 9.1 because of the small sample size, it shows the trend of the weights that subject matter experts found important when considering modes of transport.

TABLE 9.1: *Summary of decision matrix weights*

| Validation Interview number | 1 | 2 | 2 | 3 | 4 | Average |
|---|---|---|---|---|---|---|
| Commodity / general | General | FMCG | Dry bulk | General | General | |
| Reliability | 5 | 5 | 5 | 5 | 4 | 4,8 |
| Cost (tonne-km ) | 4 | 5 | 5 | 4 | 5 | 4,6 |
| Time/punctuality | 4 | 4 | 2 | 5 | 4 | 3,8 |
| Frequency of services | 3 | 5 | 2 | 5 | 4 | 3,8 |
| Tracking (communication) | 4 | 5 | 3 | 5 | 5 | 4,4 |
| Safety/security | 5 | 4 | 4 | 5 | 3 | 4,2 |
| Environment | NA | 3 | 3 | 5 | 3 | 3,5 |
| Flexibility | 1 | 5 | 3 | 4 | 2 | 3 |
| Cost (Investment) | 3 | 2 | 2 | 4 | 0 | 2,2 |
| Durability | NA | NA | NA | 3 | 0 | 1,5 |
| Political stability | NA | NA | NA | 3 | 0 | 1,5 |
| Financial stability | NA | NA | NA | 3 | 0 | 1,5 |

Some variables in the financial model have a greater influence on the total cost per tonne-km than others. The rate that RailRunner South Africa would charge the LSPs to move the freight on rail (row 101 in Figure 7.16) has a very high influence on the total cost per tonne-km of the DC-to-terminal transport method. This variable also currently has a high level of uncertainty since RailRunner South Africa is still working on establishing a final fee to charge for their service. Fluctuations in the price of fuel also have a higher influence on transport methods involving road than those involving rail. A summary of the variables that have the greatest influence on the cost per tonne-km can be seen in Table 9.2. Column H shows which variables, if changed by 20%, cause a change in the cost per tonne-km of more than 2% or 8%.

TABLE 9.2: *Summary of variables with the highest influence on the cost per tonne-km*

| 1/A | C | H |
|---|---|---|
| 4 | **ASSUMPTIONS** | |
| 5 | Number of RR trailers | **>8%** |
| 6 | Average payload of RR trailer (Tons) | **>2%** |
| 7 | Average payload of regular trailer (Tons) | **>8%** |
| 8 | **Total Average Payload (tons)** | **>8%** |
| 10 | Days to make one trip | **>2%** |
| 11 | Working days | **>2%** |
| 12 | **Number of trips made** | **>2%** |
| 13 | Average distance travelled in one trip by regular trailer (km) | **>8%** |
| 14 | **km per annum (regular trailer)** | **>8%** |

| | | |
|---|---|---|
| 17 | Average distance travelled in one trip by RR trailer on rail (km) | **>2%** |
| 20 | **Km per annum (primary mover)** | >8% |
| 24 | **CAPITAL COST** | |
| 25 | Primary Mover | **>2%** |
| 27 | Cost of one RR trailer | >2% |
| 32 | **STANDING COST** | |
| 62 | **Total wages** | >2% |
| 63 | **TOTAL STANDING COST** | >2% |
| 65 | **VARIABLE COST** | |
| 66 | Diesel price: | **>8%** |
| 67 | km/litre (primary mover) | **>8%** |
| 76 | **Total Fuel (rand)** | >8% |
| 79 | Primary mover maintenance (R/km) | **>2%** |
| 88 | **Total repair & maintenance** | >2% |
| 101 | Cost per tonne-km charged for RR trailer on rail | **>8%** |
| 102 | **Cost to move RR trailer(s) over rail** | >8% |
| 108 | **TOTAL VARIABLE COST** | >8% |
| 111 | **SUMMARY** | |
| 122 | **Cost per tonne-km** | **20%** |

## 9.3 Recommendations

### 9.3.1 Recommendations for future research

Even though this thesis makes use of both qualitative and quantitative research approaches, it leans more toward qualitative methods. It seeks to obtain rich, deep, thick data rather than the hard, reliable data that quantitative research is known for (Bryman et al., 2014). The information in this thesis could be used as a basis for future studies seeking quantitative answers to aspects of the transport industry. The following research topics, derived from this thesis, could be used as a basis for future research:

- What transport characteristics justify the use of bimodal technology?;
- Simulation of high density bimodal transport flows;
- Aspects of transport that LSPs find most important;
- What cargo types are best suited for the use of the RailRunner system?
- Case studies on different use cases such as from mine to port and seasonal fruit volumes;
- Accurate carbon emissions savings when using the RailRunner system;
- Quantifying the number of trailers and bogies needed for a frequent roadrailer/RailRunner rail service;
- Topics including the use of electrical vehicles in conjunction with rail.

These research topics (and many others) could be investigated in consultation with Transnet, RailRunner South Africa, LSPs and freight owners.

### 9.3.2 Recommendations for RailRunner South Africa

As discussed in Chapter 6 (Exploratory interviews), LSPs consider more aspects of transport than just cost. They consider reliability, speed/punctuality and safety/security to be as important if not more important than cost. Furthermore, some subject matter experts pointed out that transport time, frequency of services, flexibility and communication are a lot more important for FMCG than for dry bulk because FMCG are more sensitive to changes in lead time. This also means that FMCG have a greater need for communication between the LSP and the freight owner so that any delays can be communicated promptly if they occur. This is why some subject matter experts state that the RailRunner system is not a solution for all cargo types.

The unreliability of Transnet has been the main concern for almost every subject matter expert interviewed. This is also the main reason that they were reluctant to invest in the technology. RailRunner South Africa would most likely have to lease trailers to LSPs so that they can see for themselves if their system works or not. RailRunner South Africa would also have to make sure that the trial run on the Capecor runs smoothly so that potential RailRunner users are not deterred. A successful trial on the Capecor would help to change the long-standing negative view of rail in South Africa's transport industry.

Many subject matter experts stated that they like the innovative idea of the RailRunner system and that they would love to see it succeed. They stated that if the reliability problems of Transnet were to be resolved, then they believe the technology would be a big success.

The preliminary cost savings that LSPs could experience when using the DC-to-terminal transport method compared to the DC-to-DC method using superlink, is about 15% in terms of cost per tonne-km and about 30% in terms of cost per trailer per trip. Both of these values are well below the 10% reduction in cost at which most subject matter experts said that they would consider the use of the RailRunner system. These values are, however, highly dependent on the preliminary 30 cents per tonne-km on rail that RailRunner South Africa stated should be used in the financial model. RailRunner South Africa should ensure that they keep the cost savings of LSPs below 10% by adjusting the rate charged to move RailRunner trailers on rail.

Preliminary calculations using the Global Logistics Emissions Council Framework (SFC, 2018) show that the RailRunner system could save 60% of $CO_2$ equivalent emissions if electrical locomotives are used and 80% if diesel locomotives are used. RailRunner South Africa could use these values as another selling point once they have been calculated in more detail and with higher accuracy for specific case studies.

### 9.3.3 Recommendations for LSPs

It is important for LSPs to note that the RailRunner system is not a one-size-fits-all solution. The usefulness of the RailRunner system may vary depending on different routes taken, resources available, freight owners, commodities transported, stakeholders involved and many other factors. The finalised toolkit takes all these factors into account so that LSPs can make an informed decision on the use of the system.

LSPs must also be aware that RailRunner South Africa may be able to alleviate many of the problems that cause delays when working with Transnet. Some subject matter experts state that most of the delays seen on rail happen because of slow and inefficient terminal operations. RailRunner South Africa will take over the terminal operations from Transnet, which should increase terminal efficiency drastically and therefore decrease delays.

The RailRunner technology has a good chance of changing the freight transport industry in

South Africa in a big way. LSPs should therefore strongly consider doing case studies on the RailRunner system to see if it would be beneficial to the operations of their businesses.

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# APPENDIX A

# Full list of literature sources

## A.1 Search string keywords

Table A.1 contains the full list of keywords and synonyms used to construct search string segments as seen in Section 3.2.2

Table A.1: *Keywords used for search string segment generation*

| Keyword | road | rail | Intermodal | challenges | transport | criteria | materials | roadmap | South Africa |
|---|---|---|---|---|---|---|---|---|---|
| Synonyms | truck | train | bimodal | challenge | transportation | choice | goods | strategy | Southern Africa |
| | | | roadrailer | problems | transported | determining factors | commodities | planning | Southern African Development Community |
| | | | bi-modal | problem | | | products | | SADC |
| | | | Inter-modal | hurdles | | | | | |
| | | | modal shift | | | | | | |

## A.2 Literature database search results

Table A.2 shows how search results were acquired using the method explained in Section 3.2.2. It must also be stated that the Science Direct database has a limit on the length of search strings that can be used. The search strings that are used for other databases are therefore shortened manually to be used for the Science Direct database.

TABLE A.2: *Search results*

| Question | Overarching topics | Search string | Science Direct modified search string | Database | Date accessed | Filters applied | Number of results |
|---|---|---|---|---|---|---|---|
| \researchQuestionOne | road rail commodities intermodal | (”road”OR”truck”)AND(”rail”OR”train”)AND (”Intermodal”OR”bimodal”OR”roadrailer” OR”bi-modal”OR”Inter-modal”OR”modal shift”) AND(”materials”OR”goods”OR”commodities” OR”products”) | (”road”)AND(”rail”)AND (”Intermodal”OR”bimodal” OR”modal shift”)AND (”freight”) | Scopus | 01 June 2020 | Search in title abstract and keywords | 242 |
| | | | | ScienceDirect | 08 June 2020 | Title, abstract or author-specified keywords | 78 |
| | | | | Web of Science | 01 June 2020 | None | 83 |
| | | | | EBSCO Host | 01 June 2020 | Databases: Academic Search Premier, AfricaWide Information, MasterFILE Premier, Regional Business News, Business Source Premier<br>Search field: Abstract<br>Limit results to: Academic Journals | 203 |
| \researchQuestionTwo | road rail commodities intermodal criteria | This search string is contained in a previous search string therefore it would not contribute any new sources. | | Scopus | | | |
| | | | | ScienceDirect | | | |
| | | | | Web of Science | | | |
| | | | | EBSCO Host | | | |
| \researchQuestionThree | road rail challenges intermodal | (”road”OR”truck”)AND(”rail”OR”train”)AND (”Intermodal”OR”bimodal”OR”roadrailer” OR”bi-modal”OR”Inter-modal”OR”modal shift”) AND(”challenges”OR”challenge”OR”problems” OR”problem”OR”hurdles”) | (”road”OR”truck”)AND (”rail”OR”train”)AND (”Intermodal”OR”bimodal” OR”modal shift”)AND (”challenge”OR”problem”) | Scopus | 01 June 2020 | Search in title abstract and keywords | 209 |
| | | | | ScienceDirect | 08 June 2020 | Title, abstract or author-specified keywords | 53 |
| | | | | Web of Science | 01 June 2020 | None | 143 |
| | | | | EBSCO Host | 01 June 2020 | Databases: Academic Search Premier, AfricaWide Information, MasterFILE Premier, Regional Business News, Business Source Premier<br>Search field: Abstract<br>Limit results to: Academic Journals | 133 |
| \researchQuestionFour | road rail commodities transport criteria | (”road”OR”truck”)AND(”rail”OR”train”) AND(”criteria”OR”choice”OR”determining factors”)AND(”transport”OR”transportation” OR”transported”)AND(”materials”OR”goods” OR”commodities”OR”products”) | (”road”)AND(”rail”)AND (”criteria”OR”factors”) AND(”freight”) | Scopus | 26 May 2020 | Search in title abstract and keywords | 164 |
| | | | | ScienceDirect | 08 June 2020 | Title, abstract or author-specified keywords | 37 |
| | | | | Web of Science | 28 May 2020 | None | 50 |
| | | | | EBSCO Host | 01 June 2020 | Databases: Academic Search Premier, AfricaWide Information, MasterFILE Premier, Regional Business News, Business Source Premier<br>Search field: Abstract<br>Limit results to: Academic Journals | 119 |
| \researchQuestionFive | intermodal criteria transport commodities | (”Intermodal”OR”bimodal”OR”roadrailer”OR ”bi-modal”OR”Inter-modal”OR”modal shift”) AND(”transport”OR”transportation”OR ”transported”)AND(”criteria”OR”choice” OR”determining factors”)AND(”materials”OR ”goods”OR”commodities”OR”products”) | (”Intermodal”OR”bimodal” OR”roadrailer”)AND (”criteria”OR”factors”) AND(”commodities”OR ”goods”OR”materials”) | Scopus | 01 June 2020 | Search in title abstract and keywords | 103 |
| | | | | ScienceDirect | 08 June 2020 | Title, abstract or author-specified keywords | 141 |
| | | | | Web of Science | 01 June 2020 | None | 44 |
| | | | | EBSCO Host | 01 June 2020 | Databases: Academic Search Premier, AfricaWide Information, MasterFILE Premier, Regional Business News, Business Source Premier<br>Search field: Abstract<br>Limit results to: Academic Journals | 96 |

## A.3 Full list of literature sources

Table A.3 contains all the IDs and citations of the sources used in the meta-analysis of the structured literature review (Chapter 3).

TABLE A.3: *SLR resources and IDs*

| ID | Citation |
|---|---|
| 1 | (Fabiano et al., 2002) |
| 2 | (Dotoli, Epicoco, and Seatzu, 2015) |
| 3 | (González, Sánchez, and Romero, 2014) |
| 4 | (Aultman-Hall, Johnson, and Aldridge, 2000) |
| 5 | (Behrends, 2017) |
| 6 | (Kadama, 2014) |
| 7 | (Batterham, Mikosza, and Ockwell, 1993) |
| 8 | (Hall and Frcpc, 2012) |
| 9 | (Bärthel and Woxenius, 2004) |
| 10 | (Tadić and Zečević, 2012) |
| 11 | (Nocera and Cavallaro, 2016) |
| 12 | (Woodburn, 2013) |
| 13 | (Handler et al., 2014) |
| 14 | (Krüger, 2012) |
| 15 | (Islam, Jackson, and Robinson, 2015) |
| 16 | (Shinghal and T. Fowkes, 2002) |
| 17 | (Guo et al., 2018) |
| 18 | (Fickes, 2011) |
| 19 | (Frémont and Franc, 2010) |
| 20 | (Zhang, Wang, and Yang, 2019) |
| 21 | (Rada, Ferronato, and Torretta, 2017) |
| 22 | (Roso, Brnjac, and Abramovic, 2015a) |
| 23 | (Kwan and Knutsen, 2006) |
| 24 | (Lammgård, 2012) |
| 25 | (Mcguckin and Christopher, 2000) |
| 26 | (A. S. Fowkes, Nash, and Tweddle, 1991) |
| 27 | (Everett, 2005) |
| 28 | (Ludvigsen, 2009) |
| 29 | (Kreutzberger, 2010) |
| 30 | (Fernando, Fei, and Stanley, 2019) |
| 31 | (Flodén, 2016) |
| 32 | (Dotoli, Epicoco, Falagario, et al., 2014) |
| 33 | (Nocera, Cavallaro, and Irranca Galati, 2018) |
| 34 | (Smith and Haight, 1980) |
| 35 | (Liimatainen et al., 2018) |
| 36 | (Wolfsmayr and Rauch, 2014) |
| 37 | (Pirie, 1993) |
| 38 | (van Riessen, Negenborn, and Dekker, 2016) |
| 39 | (Esposito, Cicatiello, and Ercolano, 2020) |
| 40 | (Sloss, 1970) |
| 41 | (Bubbico, Di Cave, and Mazzarotta, 2004) |

TABLE A.3: *SLR resources and IDs*

| ID | Citation |
|---|---|
| 42 | (Bubbico, Maschio, et al., 2006) |
| 43 | (Pinto et al., 2018) |
| 44 | (Africa Research Bulletin, 2017) |
| 45 | (Henning, Sass, and Sander, 2000) |
| 46 | (CILT International, 2005) |
| 47 | (Natarajan, Duncan, and D. Simpson, 2005) |
| 48 | (Picinin et al., 2011) |
| 49 | (DHL Logistik, 2008) |
| 50 | (McKinnon, 2005) |
| 51 | (Černá, Zitrický, and Daniš, 2017) |
| 52 | (Ližbetin and Caha, 2015) |
| 53 | (Tudorica and Banacu, 2017) |
| 54 | (Zamboni, 1997) |
| 55 | (Florin, 2016) |
| 56 | (Baindur, Sitharam, and Harinaryana, 2010) |

# APPENDIX B

# Preliminary toolkit

## B.1 Introduction

This chapter looks at the preliminary toolkit and how it was constructed using the information from Chapters 2 - 5. The financial model and decision matrix in this toolkit will be used as inputs to the structure of exploratory interviews. The interviews will then be used to add to and refine the toolkit. This process can be seen in Figure B.1.

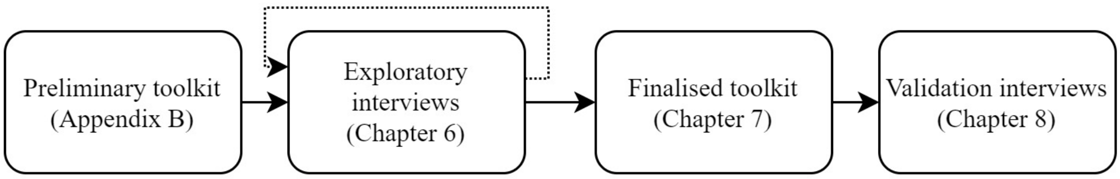


FIGURE B.1: *Toolkit flow of completion*

This chapter/preliminary toolkit contains the tools listed below:

- A section explaining what the RailRunner system/technology is;
- Selection criteria for LSPs that can benefit from the RailRunner system;
- Stakeholder analysis on the role players that may have an interest or influence on the decision to use the RailRunner system;
- A financial model comparing the operating costs of road-only systems with systems involving the RailRunner technology;
- A decision matrix that assists LSPs to quantify and visualise their attitudes towards different transport methods;
- A section on frequently asked questions that helps to clear up any misconceptions of the RailRunner system or technology.

This chapter aims to form part of the input to research objective four (finalised toolkit) as seen in Section 1.4.4.

## B.2 The RailRunner system/technology

This section will contain everything that a user of the toolkit may need to know about the RailRunner system and company. All the information in this section will be taken from Chapter 4.

## B.3 Selection criteria

The selection criteria in this section will be taken from Chapter 5. It could be used by LSPs to determine the viability of using the RailRunner system.

## B.4 Stake holder analysis

An important part of the decision to use RailRunner technology is stakeholder analysis. Everyone that could influence, or be interested in, the decision should be considered. A power-interest matrix is used so that stakeholders can be categorized according to their level of power and interest. The structure of this matrix can be seen in Figure B.2.

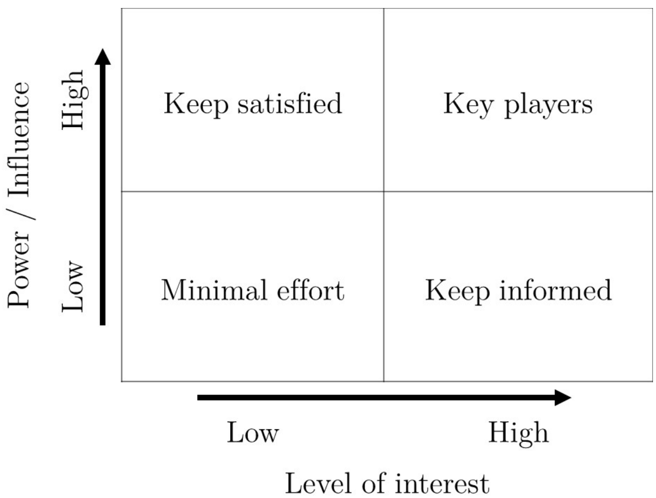


Figure B.2: *Power-interest matrix (Mendelow, 1991)*

It is difficult (if not impossible) to establish an exhaustive list of stakeholders. Therefore, the exploratory interviews will be used to establish only suggestions and examples of roles that can be labelled according to the labels in the power-interest matrix.

## B.5 Financial model

The best way to quantify the cost savings when using the RailRunner system is by using a financial model. This section will discuss a financial model that compares different methods of transport, some of which make use of the RailRunner system. These methods are discussed in Section B.5.1. Section B.5.2 discusses how the financial model should be interpreted. Lastly, Section B.5.3 discusses the structure of the financial model and the calculations within it.

This financial model is based on the truck operating benchmarks set up by Braun (2019) that were discussed in Section 2.12. It will be included in the exploratory interviews so that any changes or additions can be made.

### B.5.1 Methods of transport

The methods of transport compared in the financial model are as follows:

- DC-to-DC;
- catching-your-own-pass;
- DC-to-terminal.

The DC-to-DC method is used as the control while the catching-your-own-pass and DC-to-terminal methods involve the use of RailRunner technology. Each one of these methods are discussed in the subsections below.

#### DC-to-DC transport method

This method is the control case. It involves a tuck that uses a regular trailer to move freight between DCs on road. The following process and the accompanying figure (B.3) describe this method:

1. The primary mover moves a full trailer from an origin DC/supplier to a destination DC via road.
2. The primary mover moves the empty trailer from the destination DC to the origin DC/supplier.


FIGURE B.3: *DC-to-DC transport method*

A trip is completed when one cycle of the above process is completed. The trailer in this scenario is full on every trip since this is the market that RailRunner aims to tap into (no empty back-haul). A trip is completed when one cycle of this process is completed.

#### Catching-your-own-pass transport method

This method involves moving one regular trailer on road, and one or more RailRunner trailers on rail simultaneously. The following process and the accompanying figure (B.4) describe this method:

1. The primary mover moves a full trailer from an origin DC/supplier to a destination DC via road.

2. The primary mover goes to the terminal and moves a full RailRunner trailer back to the DC.

3. The empty trailers are moved to other DCs/suppliers so that they can be refilled.

4. The RailRunner trailers are moved back to the terminal so that they can be transported on rail to the destination terminal.

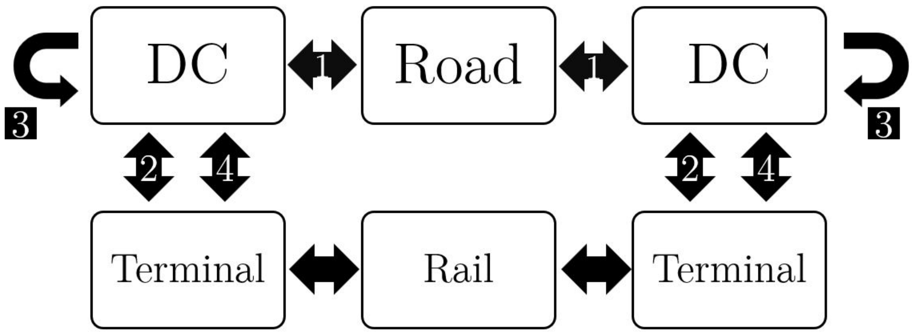


FIGURE B.4: *catching-your-own-pass transport method*

A trip is completed when one cycle of the above process is completed. The LSP can own multiple RailRunner trailers if they can be unloaded, loaded, and returned to the terminal before the next train leaves.

**DC-to-terminal transport method**

This method involves two (or more) primary movers, each moving multiple RailRunner trailers between DCs/suppliers and terminals at the endpoint of each corridor. The following process and the accompanying figure (B.5) describe this method:

1. The primary mover moves a full RailRunner trailer from the terminal to the DC.

2. The empty trailers are moved to other DCs/suppliers so that they can be refilled.

3. The filled RailRunner trailers are moved back to the terminal.

4. The trailers are transported on rail to the destination terminal.

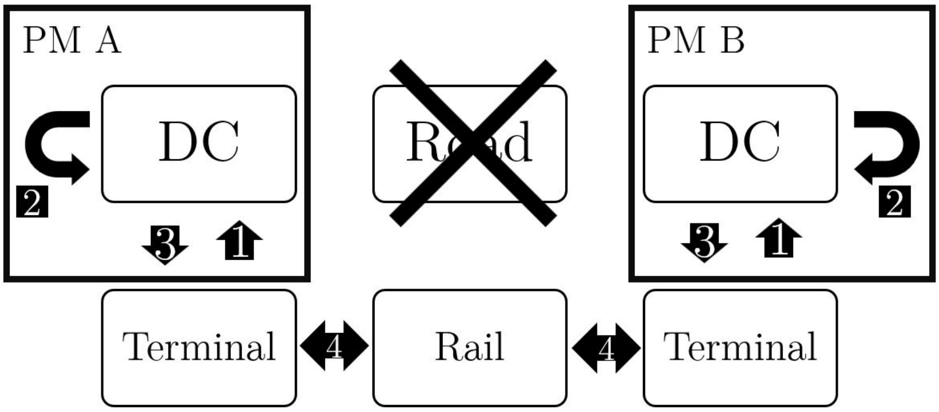


FIGURE B.5: *DC-to-terminal transport method*

A trip is completed when one cycle of the above process is completed. The LSP can own multiple RailRunner trailers if they can be unloaded, loaded, and returned to the terminal before the next train leaves.

### B.5.2 Financial model interpretation

The financial model is in the form of a spreadsheet. It contains multiple variables and calculations. This section discusses how each of these variables and calculations should be interpreted. Table B.1 shows the key that should be used alongside the financial model.

TABLE B.1: *Financial model key*

| | |
|---|---|
| | A white background represents a variable that can be changed. |
| | A light grey background represents calculations that only simplify the process of populating the table. These calculations can be overwritten by the user if they wish to do so. |
| **Bold** | A dark grey background with bold text represents a calculation that cannot be overwritten by the user. These calculations form part of the structure of the financial model. |
| NA | A black background with white text represents entries that are not applicable to the specific method of transport. |
| **2%** | Above 2% change in tonne-km if a 20% change is made in the variable. |
| **8%** | Above 8% change in tonne-km if a 20% change is made in the variable. |

Sensitivity analysis was done to determine how much influence an entry in the financial model has. Some rows in the financial model contain a "2%" or an "8%" in the right-hand column. These values indicate that if the values in that row change by 20%, then the overall cost per tonne-km (in row 122) changes by more than 2% or 8%.

The industry standard vehicle used in long-distance road freight transport is a 7—axle superlink. Therefore, it is included in the comparison with the 6—axle articulated vehicle that RailRunner

South Africa intends to use. An example of a 7—axle superlink (box trailer) and a 6—axle articulated vehicle (box trailer) can be seen in Figures B.6 and B.7, respectively.

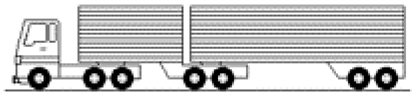

FIGURE B.6: *7-axle superlink (box trailer)*

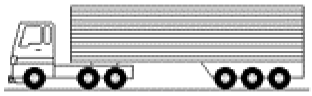

FIGURE B.7: *6-axle articulated vehicle (box trailer)*

Since a RailRunner trailer in the form of a superlink is not a feasible option, it can only be used as a DC-to-DC transport method. It must also be stated that a 6—axle articulated vehicle is not commonly used for long-distance DC-to-DC road transport. It is only included in the financial model so that its values can be compared to those of the transport methods including RailRunner. The following transport methods are compared in the financial model:

- DC-to-DC (7-axle vehicle with a superlink trailer);
- DC-to-DC (6-axle vehicle with a regular tri-axle trailer);
- Catching your own pass (Uses one regular trailer and one or more RailRunner trailers);
- DC-terminal (Uses multiple RailRunner trailers only).

### B.5.3 Financial model structure

This section discusses the variables and formulas used in the financial model. The financial model is made up of the following five parts:

- Assumptions;
- Capital cost;
- Standing cost;
- Variable cost;
- Comparison summary.

Each subsection below will discuss a different part of the financial model. Each of the subsections will contain a table showing the structure of the financial model which is accompanied by notes and recommended values for the variables in the table.

### Assumptions

The first section of the financial model establishes the assumptions made that the rest of the financial model is based on. Tables B.2 and B.3 show the variables and formulas used.

TABLE B.2: *Financial model: Assumptions*

| 1/A | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|
| 3 | | Transport method | DC to DC (super link) | DC to DC (tri-axle) | Catching your own pass | DC to Terminal (2 primary movers) | |
| 4 | **ASSUMPTIONS** | | | | | | |
| 5 | | Number of RR trailers | NA | NA | | | >8% |
| 6 | | Average payload of RR trailer (Tons) | NA | NA | E7 | E7 | >2% |
| 7 | | Average payload of regular trailer (Tons) | | | E7 | NA | >8% |
| 8 | | **Total Average Payload (tons)** | **D7** | **E7** | **F7+F6 *F5** | **G6* G5** | >8% |
| 9 | | Deck length (metres) | | | E9 | E9 | |
| 10 | | Days to make one trip | | D10 | D10+1 | D10+1 | >2% |
| 11 | | Working days | | D11 | D11 | D11 | >2% |
| 12 | | **Number of trips made** | **D11/ D10** | **E11/ E10** | **F11/ F10** | **G11/ G10** | >2% |
| 13 | | Average distance travelled in one trip by regular trailer (km) | | D13 | D13 | NA | >8% |
| 14 | | **km per annum (regular trailer)** | **D13* D12** | **E13* E12** | **F13* F12** | NA | >8% |
| 15 | | Average distance travelled in one trip by RR trailer on road (km) | NA | NA | | F15 | |
| 16 | | **Km per annum (RR trailer) on road** | NA | NA | **F15* F12** | **G15* G12** | |
| 17 | | Average distance travelled in one trip by RR trailer on rail (km) | NA | NA | | F17 | >2% |

**Row 5 (Number of RailRunner trailers):** RailRunner South Africa states that a truck should be able to handle the collection, unloading, loading and delivery back to a terminal of four RailRunner trailers in one day. The primary mover in the catching-your-own-pass transport method would therefore be able to handle the movements of three RailRunner trailers and one regular trailer.

The following example can be used as a base model for calculating the number of RailRunner trailers that can be used in the DC-to-terminal method: If a trip takes three days (one day between DC and the terminal, one day on rail and one day between terminal and DC) then the DC-to-terminal system would be able to handle 16 RailRunner trailers. This number is calculated by adding up two sets of four RailRunner trailers between the origin and destination DCs and terminals, and two sets of four travelling on the rail between the origin and destination terminals as seen in Figure B.8. This model can be expanded. If the time on rail were to be two days, then two extra sets of four trailers could be added to the system and so on. If the time to move trailers between the DCs and terminals were to be longer than one day, then the number of trailers would have to be decreased.

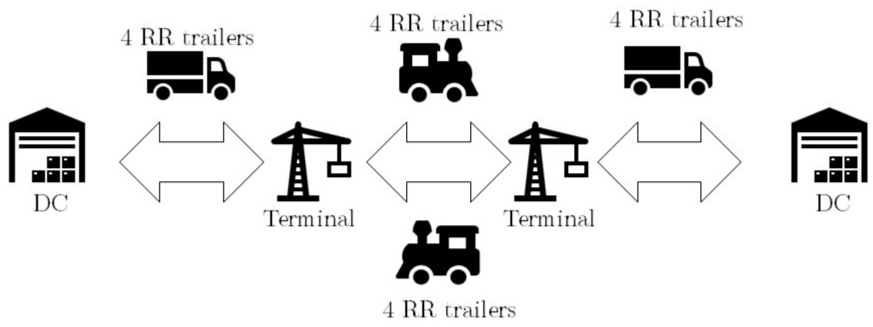


FIGURE B.8: *16 RailRunner trailers in DC-to-terminal system*

**Row 6 (Average payload of RailRunner trailer (tons)):** The maximum allowable weight of a tri-axle trailer is just over 28 tonnes (TruckScience, 2021). The RailRunner trailers are roughly 5 tonnes heavier than regular trailers. This limits the carrying capacity of the RailRunner trailers to a maximum of 24 tonnes.

**Row 8 (Total average payload (tons)):** This is equal to the average payload of one regular trailer for the DC-to-DC methods. For the catching-your-own-pass method this is the average payload of one regular trailer plus the average payload of all the RailRunner trailers in the system.

The DC-to-terminal method can be seen as transporting [number of RailRunner trailers in the system / number of days to transport the trailers] trailers every day, or it can be seen as transporting [number of RailRunner trailers in the system] trailers every [days to make one trip] days. This will yield the same number of trailers transported per annum. The latter way of thinking is used in the financial model to simplify calculations.

**Row 9 (Deck length):** The deck length of a superlink trailer is 18,17 metres (Braun, 2019) and RailRunner South Africa states that the deck length of a RailRunner trailer is 13,65 metres.

**Row 10 (Days to make one trip):** RailRunner South Africa states that their goal is for transport involving RailRunner technology to be one day slower than road transport.

**Row 12 (Number of trips made):** The number of trips made is the number of working days divided by the number of days to make one trip.

**Row 13 (Average distance travelled in one trip by regular trailer (km)):** This is the distance between the two DCs plus some distance to reposition empty trailers to other DCs to pick up new loads.

**Row 14 (Km per annum (regular trailer)):** This is the average distance travelled in one trip by a regular trailer multiplied by the number of trips made in one year.

**Row 15 (Average distance travelled in one trip by RailRunner trailer on road (km)):** This is the sum of the distance between DC and terminal at the origin and destination.

**Row 16 (Km per annum (RailRunner trailer) on road):** This is the average distance travelled in one trip by a RailRunner trailer on road multiplied by the number of trips made in one year.

**Row 17 (Average distance travelled in one trip by RailRunner trailer on rail (km)):** This is the distance of rail between the origin terminal and destination terminal.

TABLE B.3: *Financial model: Assumptions continued*

| A | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|
| 3 | | Transport method | DC to DC (super link) | DC to DC (tri-axle) | Catching your own pass | DC to Terminal (2 primary movers) | |
| 18 | | **Km per annum (RR trailer) on rail** | NA | NA | **F17* F12** | **G17* G12** | |
| 19 | | Average distance travelled in one trip by primary mover(s) (km) | D13 | E13 | **F13+2 *F15*F5** | **2*G15 *G5** | |
| 20 | | **Km per annum (primary mover)** | **D12* D19** | **E12* E19** | **F12* F19** | **G12*G19** | >8% |
| 21 | | **tonne-km regular freight** | **D8* D14** | **E8* E14** | **F14* F7** | NA | |
| 22 | | **tonne-km RR freight** | NA | NA | **(F18+ F16)*F6** | **(G18+ G16)*G6** | |
| 23 | | **Total tonne-km** | **D21** | **E21** | **F21+ F22*F5** | **G22*G5** | |

**Row 18 (Km per annum (RailRunner trailer) on rail):** This is the average distance travelled in one trip by a RailRunner trailer on rail multiplied by the number of trips made in one year.

**Row 19 (Average distance travelled in one trip by primary mover (km)):** These values are based on the definition of a trip as described in Section B.5.1. For the DC-to-DC method the distance is equal to the distance that the regular trailer travels in one trip. For the catching-your-own-pass method, the distance that the primary mover moves is the distance that the regular trailer travels in a trip plus the average distance that the combined RailRunner trailers move on road in one trip multiplied by two to account for some empty back-haul when the primary mover is moving without a trailer. Similarly, the DC-to-terminal method uses the average distance that the combined RailRunner trailers move in one trip on road multiplied by two to account for some empty back-haul when the primary mover is moving without a trailer.

**Row 21 (tonne-km regular freight):** The weight in tonnes of the average load on a regular trailer multiplied by the distance in km that the regular trailer travels per annum.

**Row 22 (tonne-km RailRunner freight):** The weight in tonnes of the average load on a RailRunner trailer multiplied by the distance in km that the RailRunner trailer travels on road and rail per annum. This is calculated for one RailRunner trailer only.

**Row 23 (Total tonne-km):** The tonne-km of the regular trailers plus the tonne-km of all the RailRunner trailers combined.

### Capital cost

The second section of the financial model calculates the total capital cost of all the equipment used. Table B.4 shows the variables and formulas used.

TABLE B.4: *Financial model: Capital cost*

| A | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|
| 3 | | Transport method | DC to DC (super link) | DC to DC (tri-axle) | Catching your own pass | DC to Terminal (2 primary movers) | |
| 24 | **CAPITAL COST** | | | | | | |
| 25 | | Primary Mover | | D25 | D25 | 2*D25 | >2% |
| 26 | | Auxiliary equipment | | | E26 | E26 | |
| 27 | | Cost of RR trailer | NA | NA | | F27 | >2% |
| 28 | | **Total cost of RR trailers** | NA | NA | **F27*F5** | **G27*G5** | |
| 29 | | Regular Trailer | | | E29 | NA | |
| 30 | | Other | | D30 | D30 | D30 | |
| 31 | | **TOTAL CAPITAL COST** | **D30 +D29 +D26 +D25** | **E30 +E29 +E26 +E25** | **F30+ F29+ F28+ F26+ F25** | **G30+ G28+ G26+ G25** | |

**Row 25 (Primary mover):** This is the cost of the primary mover. Take note that there are two primary movers in the DC-to-terminal method.

**Row 26 (Auxiliary equipment):** Cost of any auxiliary equipment such as underslung diesel generators for refrigerated trailers/containers.

**Row 27 (Cost of a RailRunner trailer):** RailRunner South Africa stated that the price would be around R700 000 for RailRunner trailers.

**Row 28 (Total cost of RailRunner trailers):** The combined cost of all the RailRunner trailers in the system.

**Row 29 (Regular trailer):** The cost of a regular trailer.

**Row 30 (Other costs):** This is any other capital costs that may not fall under the categories above.

**Row 31 (Total capital cost):** The sum of the primary movers, auxiliary equipment, trailers, and other equipment.

### Standing cost

The third section of the financial model calculates the total standing cost of the transport methods. Tables B.5, B.6, B.7 and B.8 show the variables and formulas used.

TABLE B.5: *Financial model: Standing cost (depreciation)*

| A | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|
| 3 | | Transport method | DC to DC (super link) | DC to DC (tri-axle) | Catching your own pass | DC to Terminal (2 primary movers) | |
| 32 | **STANDING COST** | | | | | | |
| 33 | Depreciation | Primary mover (over number of years) | | D33 | D33 | D33 | |
| 34 | | Auxiliary (over number of years) | | D34 | D34 | D34 | |
| 35 | | Regular trailer (over number of years) | | D35 | D35 | D35 | |
| 36 | | RR trailer (over number of years) | NA | NA | D35 | D35 | |
| 37 | | **Primary mover depreciation** | **D25/ D33** | **E25/ E33** | **F25/F33** | **G25/G33** | |
| 38 | | **Auxiliary depreciation** | **D26/ D34** | **E26/ E34** | **F26/F34** | **G26/G34** | |
| 39 | | **RR Trailer depreciation** | NA | NA | **F27/F36** | **G27 /G36** | |
| 40 | | **Total RR trailer depreciation** | NA | NA | **F5*F39** | **G5*G39** | |
| 41 | | **Regular trailer depreciation** | **D29/ D35** | **E29/ E35** | **F29/F35** | NA | |
| 42 | | **Total depreciation** | **D41 +D38 +D37** | **E41 +E38 +E37** | **F41+ F40+ F38+ F37** | **G40+ G38+ G37** | |

**Row 33-36 (Depreciation of equipment (over number of years)):** The number of years that the various equipment depreciates over. Braun (2019) states that trucks depreciate at least 20% per annum. This is equivalent to the depreciating to a value of zero over five years. Furthermore, they state that auxiliary equipment depreciates over four years and trailers depreciate over ten years.

**Row 37-42 (Depreciation of equipment):** The annual depreciation of each item of equipment. This is calculated as the value of the item divided by the number of years that it depreciates over. These calculations assume no residual value.

**Row 43 (Interest rate):** The interest rate charged on the capital owned.

**Row 44-48 (Interest paid in year 1-5):** This is calculated as the total cost of capital minus the depreciation of capital up until that year. This is then multiplied by the interest rate.

Table B.6: *Financial model: Standing cost (capital cost)*

| A | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|
| 3 | | Transport method | DC to DC (super link) | DC to DC (tri-axle) | Catching your own pass | DC to Terminal (2 primary movers) | |
| 43 | Capital cost | Interest rate | | | | | |
| 44 | | **Interest paid in year 1** | **(D31) *D43** | **(E31) *D43** | **(F31) *D43** | **(G31)* D43** | |
| 45 | | **Interest paid in year 2** | **(D31-D42* 1)* D43** | **(E31-E42* 1)* D43** | **(F31-F42*1)* D43** | **(G31-G42*1)* D43** | |
| 46 | | **Interest paid in year 3** | **(D31-D42 *2)* D43** | **(E31-E42 *2)* D43** | **(F31-F42*2) *D43** | **(G31-G42*2) *D43** | |
| 47 | | **Interest paid in year 4** | **(D31-D42 *3)* D43** | **(E31-E42 *3)* D43** | **(F31-F42*3) *D43** | **(G31-G42*3) *D43** | |
| 48 | | **Interest paid in year 5** | **(D31-D42 *4)* D43** | **(E31-E42 *4)* D43** | **(F31-F42*4) *D43** | **(G31-G42*4) *D43** | |
| 49 | | **Cost of capital (average interest paid over 5 years)** | **AVER AGE (D44: D48)** | **AVER AGE (E44: E48)** | **AVER AGE (F44:F48)** | **AVER AGE (G44:G48)** | |

**Row 49 (Cost of capital (average interest paid over 5 years)):** This is the average interest paid over five years.

TABLE B.7: *Financial model: Standing cost (licences, insurance, and wages)*

| A | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|
| 3 | | Transport method | DC to DC (super link) | DC to DC (tri-axle) | Catching your own pass | DC to Terminal (2 primary movers) | |
| 50 | Licence | Primary mover licence | | D50 | D50 | D50*2 | |
| 51 | | RR trailer licence | NA | NA | E53 | E53 | |
| 52 | | **Total RR trailer licence cost** | NA | NA | **F5*F51** | **G5*G51** | |
| 53 | | Regular trailer licence | | | E53 | NA | |
| 54 | | **Total licence fee** | **D53+ D50** | **E53+ E50** | **F53+F52 +F50** | **G52+G50** | |
| 55 | Insurance | Insurance % of total capital cost | | | | | |
| 56 | | **Total insurance** | **D31* D55** | **E31* D55** | **F31* D55** | **G31* D55** | |
| 57 | Wages | Driver wages per month | | D57 | D57 | D57*2 | |
| 58 | | Driver bonus/overtime | | | | | |
| 59 | | **Driver wages per annum** | **(D57+ D58)* 12** | **(E57+ E58)* 12** | **(F57+ F58)* 12** | **(G57+ G58) *12** | |
| 60 | | Assistant wages per month | | D60 | D60 | D60*2 | |
| 61 | | **Assistant wages per annum** | **D60* 12** | **E60* 12** | **F60*12** | **G60*12** | |
| 62 | | **Total wages** | **D61+ D59** | **E61+ E59** | **F61+F59** | **G61+G59** | >2% |

**Row 50-54 (Licence fees):** This is the licence fees for the primary movers and the trailers. Braun (2019) states that the licencing fees should be R17 280 for a 7-axle superlink trailer and R8 472 for a tri-axle trailer. RailRunner South Africa states that the licence fee for a RailRunner trailer is the same as a regular tri-axle trailer.

**Row 55-56 (Insurance cost):** This is the total insurance cost is calculated as a percentage of the total capital cost.

**Row 57-62 (Wages):** These are the wages of the drivers and driver assistants. Note that the DC-to-terminal method involves two primary movers and therefore requires twice the number of wages. Braun (2019) suggests a value of R28 000.

**Row 63 (Total standing costs):** This is the sum of the total depreciation, capital cost, licence fees, insurance cost and wages.

**Row 64 (Standing cost as a percentage of total operating cost):** This is the total standing cost divided by the total operating costs (calculated in row 110).

Table B.8: *Financial model: Standing cost (summary)*

| A | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|
| 3 | | Transport method | DC to DC (super link) | DC to DC (tri-axle) | Catching your own pass | DC to Terminal (2 primary movers) | |
| 63 | | **TOTAL STANDING COST** | **D42+ D49+ D54+ D56+ D62** | **E42+ E49+ E54+ E56+ E62** | **F42+ F49+ F54+ F56+ F62** | **G42+ G49+ G54+ G56+ G62** | >**2%** |
| 64 | | **As a % of total operating cost** | **D63/ D112** | **E63/ E112** | **F63/ F112** | **G63/ G112** | |

### Variable cost

The fourth section of the financial model calculates the total variable cost of the transport methods. Tables B.9, B.10, B.11 and B.12 show the variables and formulas used.

**Row 67-70 (Primary mover fuel):** This is the cost of the fuel that the primary mover uses is based on the price of fuel, the distance travelled per annum by the primary movers, and the fuel economy of the primary mover.

**Row 71-74 (Auxiliary fuel):** This is the cost of the fuel that the auxiliary equipment uses based on the price of fuel, the hours spent operating per annum, and the litres used per hour.

**Row 75-76 (Total fuel):** This is the total fuel used and the cost thereof. It must be noted that the DC-to-DC transport methods are more severely affected by fluctuations in fuel price than transport methods involving the RailRunner system.

**Row 77-78 (Oil used):** This is the cost of oil used.

TABLE B.9: *Financial model: Variable cost (fuel and oil)*

| A | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|
| 3 | | Transport method | DC to DC (super link) | DC to DC (tri-axle) | Catching your own pass | DC to Terminal (2 primary movers) | |
| 65 | **VARIABLE COST** | | | | | | |
| 66 | | Diesel price: | | | | | >8% |
| 67 | | km/litre (primary mover) | | D67 | D67 | D67 | >8% |
| 68 | | **L/100-km (primary mover)** | **100/ D67** | **100/ E67** | **100/ F67** | **100/ G67** | |
| 69 | Fuel | **Total primary mover litres** | **D20/ D67** | **E20/ E67** | **F20/F67** | **G20/G67** | |
| 70 | | **Cost (primary mover)** | **D69* D66** | **E69* D66** | **F69* D66** | **G69* D66** | |
| 71 | | L/Hr (Auxiliary) | | D71 | D71 | D71 | |
| 72 | | Hours per annum (Auxiliary) | | D72 | D72 | D72 | |
| 73 | | **Total Auxiliary Litres** | **D72* D71** | **E72* E71** | **F72* F71** | **G72* G71** | |
| 74 | | **Cost (Auxiliary)** | **D73* D66** | **E73* D66** | **F73* D66** | **G73* D66** | |
| 75 | | **Total Litres** | **D69+ D73** | **E69+ E73** | **F69+ F73** | **G69+ G73** | |
| 76 | | **Total Fuel (rand)** | **D75* D66** | **E75* D66** | **F75* D66** | **2*G75* D66** | >8% |
| 77 | Oil | Top up oil % of total vehicle fuel cost | | | | | |
| 78 | | **Top-up oil** | **D76* D77** | **E76* D77** | **F76* D77** | **G76* D77** | |

TABLE B.10: *Financial model: Variable cost (maintenance)*

| A | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|
| 3 | | Transport method | DC to DC (super link) | DC to DC (tri-axle) | Catching your own pass | DC to Terminal (2 primary movers) | |
| 79 | Maintenance | Primary mover maintenance (R/km) | | D79 | D79 | D79 | >2% |
| 80 | | Auxiliary maintenance (R/hr) | | D80 | D80 | D80 | |
| 81 | | Regular trailer maintenance (R/km) | | | E81 | NA | |
| 82 | | RR trailer maintenance (R/km) | NA | NA | | F82 | |
| 83 | | **Primary mover repair & maintenance** | **D79*D20** | **E79*E20** | **F79*F20** | **G79*G20*2** | |
| 84 | | **Auxiliary repair & maintenance** | **D80*D72** | **E80*E72** | **F80*F72** | **G80*G72** | |
| 85 | | **RR trailer repair & maintenance** | NA | NA | **F82*F16** | **G82*G16** | |
| 86 | | **Total RR Trailer repair & maintenance** | NA | NA | **F5*F85** | **G5*G85** | |
| 87 | | **Regular trailer repair & maintenance** | **D81*D20** | **E81*E20** | **F81*F14** | NA | |
| 88 | | **Total repair & maintenance** | **D87+D84+D83** | **E87+E84+E83** | **F87+F84+F83+F86** | **G84+G83+G86** | >2% |

**Row 79-88 (Maintenance):** Maintenance costs are based on the cost per km or the cost per hour of moving or running equipment, respectively. The distance travelled per annum on road is used to calculate the maintenance cost for primary movers and trailers, and the hours run per annum is used for auxiliary equipment.

TABLE B.11: *Financial model: Variable cost (tyres)*

| A | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|
| 3 | | Transport method | DC to DC (super link) | DC to DC (tri-axle) | Catching your own pass | DC to Terminal (2 primary movers) | |
| 89 | Tyres (new) | Number fitted | | | (E89/22) *(10+12 *(1+F5)) | (E89/22) *(10+12 *G5) | |
| 90 | | **Number used** | **(D93/ D91)* D89** | **(E93/ E91)* E89** | **(F93/ F91)* F89** | **(G93/ G91)* G89** | |
| 91 | | Km expected | | D91 | D91 | D91 | |
| 92 | | Price new | | D92 | D92 | D92 | |
| 93 | | **Km per annum of wheels** | **D20** | **E20** | **F16*F5 +F14** | **G5*G16** | |
| 94 | | **Total cost of new tyres** | **D92* D90** | **E92* E90** | **F92*F90** | **G92*G90** | |
| 95 | Tyres (re-treads) | Number fitted | | | (E95/22) *(10+12 *(1+F5)) | (E95/22) *(10+12 *G5) | |
| 96 | | **Number used** | **(D93/ D97)* D95** | **(E93/ E97)* E95** | **(F93/ F97)* F95** | **(G93/ G97)* G95** | |
| 97 | | Km expected | | D97 | D97 | D97 | |
| 98 | | Price re-tread | | D98 | D98 | D98 | |
| 99 | | **Total cost of re-treads** | **D98* D96** | **E98* E96** | **F98* F96** | **G98*G96** | |
| 100 | | **Total tyres** | **D94+ D99** | **E94+ E99** | **F94+ F99** | **G94+ G99** | |

**Row 89 (Number of new tyres fitted):** The total number of tyres fitted to a 7-axle and 6-axle truck is 26 and 24, respectively. Some of these tyres are new and some are re-treads. To calculate the number of new tyres needed for the catching-your-own-pass and DC-to-terminal methods the ratio of new tyres to total tyres fitted must first be calculated. This is then multiplied by the total number of tyres on the primary mover and trailers used in each method.

**Row 90 (Number of new tyres used):** This is the km per annum travelled by the wheels divided by the distance in km expected of each tyre. This value is then multiplied by the number of new tyres fitted.

**Row 91 (Km expected):** The distance in km that the tyres are expected to last.

**Row 92 (Price of new tyres):** This is the price of one new tyre. These prices vary widely.

**Row 93 (km per annum of wheels):** This is the distance that the tyres travel in km per annum. In the DC-to-DC method the distance is equal to the distance that the primary mover moves. In the catching-your-own-pass and DC-to-terminal method the total distance that all the trailers in the system travel on road is used. This does not consider the distance that the tyres on the primary mover move or the differences in the distances that the tyres move on RailRunner trailers or regular trailers. To accurately calculate the values in detail would however greatly complicate the model, and since the cost of tyres have a very small influence in the cost per tonne-km, these simplified calculations are used.

**Row 94 (Total cost of new tyres):** This is the price of new tyres multiplied by the number of new tyres used.

**Row 95 (Number of re-treads fitted):** The total number of tyres fitted to a 7-axle and 6-axle truck is 26 and 24, respectively. Some of these tyres are new and some are re-treads. To calculate the number of re-tread tyres needed for the catching-your-own-pass and DC-to-terminal methods the ratio of re-tread tyres to total tyres fitted must first be calculated. This is then multiplied by the total number of tyres on the primary mover and trailers used in each method.

**Row 96 (Number of re-tread tyres used):** This is the km per annum travelled by the wheels divided by the distance in km expected of each tyre. This value is then multiplied by the number of re-tread tyres fitted.

**Row 97 (Km expected):** This is the distance in km that the tyres are expected to last.

**Row 98 (Price of re-tread tyres):** This is the price of one re-tread tyre. These prices vary widely. A price of R3400 per re-tread tyre can be used if one is unsure of the actual price.

**Row 99 (Total cost of re-tread tyres):** This is the price of re-tread tyres multiplied by the number of re-tread tyres used.

**Row 100 (Total cost of tyres):** This the combined cost of all the new and re-tread tyres.

**Row 101 (Cost per tonne-km charged for a RailRunner trailer on rail):** This is the cost that RailRunner South Africa will charge LSPs to move their RailRunner trailers on rail. This is charged per tonne-km which is the industry standard unit of measurement for freight transport on rail. RailRunner South Africa is still undecided on the fee that they will charge but a cost of R0.30 per tonne-km is the value that they suggested for now.

**Row 102 (Cost to move RR trailer(s) over rail):** This is the cost per tonne-km multiplied by the tonne-km that is moved by the RailRunner trailers on rail.

**Row 103 (Terminal handling cost):** This is the cost of handling one RailRunner trailer at the origin and destination terminal. Currently, this value is included in the cost per tonne-km, but it was left in for if this were to change.

**Row 104 (Total terminal handling cost):** The cost of handling all the RailRunner trailers in a year.

**Row 105 (Unforeseen expense):** Any expenses that may not be evident beforehand. Braun (2019) suggests that this value should be R125 000, and RailRunner South Africa suggests that it should be slightly more, with a value of R300 000.

**Row 106 (Total variable cost):** This is the sum of the cost of fuel, oil, repair and maintenance, tyres, tolls and rial costs.

**Row 107 (Variable cost as a percentage of total operating cost):** This is the total variable cost divided by the total operating costs (calculated below).

**Row 108 (Total operating costs):** This is the total standing costs plus the total variable cost.

TABLE B.12: *Financial model: Variable cost (rail cost, tolls, and summary)*

| A | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|
| 3 | | Transport method | DC to DC (super link) | DC to DC (tri-axle) | Catching your own pass | DC to Terminal (2 primary movers) | |
| 101 | Rail cost | Cost per tonne-km charged for RR trailer on rail | NA | NA | | F101 | >8% |
| 102 | | **Cost to move RR trailer(s) over rail** | NA | NA | **F101*F6 *F18*F5** | **G101*G6 *G18*G5** | >8% |
| 103 | | Terminal handling cost | NA | NA | | F103 | |
| 104 | | **Total terminal handling cost** | NA | NA | **F103* F12*F5** | **G103* G12*G5** | |
| 105 | | Unforeseen expense | | | | F105 | |
| 106 | | **TOTAL VARIABLE COST** | **SUM( D76+ D78+ D88+ D100+ D105)** | **SUM( E76+ E78+ E88+ E100+ E105)** | **SUM( F76+ F78+ F88+ F100+ F105+ F102+ F104)** | **SUM( G76+ G78+ G88+ G100+ G105+ G102+ G104)** | >8% |
| 107 | | **As a % of total operating cost** | **D106/ D108** | **E106/ E108** | **F106/ F108** | **G106/ G108** | |
| 108 | | **TOTAL OPERATING COSTS** | **D63+ D106** | **E63+ E106** | **F63+ F106** | **G63+ G106** | |

### Comparison summary

The fifth section of the financial model calculates the comparison summary of the transport methods. Tables B.13 and B.14 show the variables and formulas used. These values can be used to see what transport methods perform better in terms of cost.

TABLE B.13: *Financial model: Comparison summary*

| A | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|
| 3 | | Transport method | DC to DC (super link) | DC to DC (tri-axle) | Catching your own pass | DC to Terminal (2 primary movers) | |
| 109 | **Summary** | | | | | | |
| 110 | | **Standing cost rand per/day** | **D63/ D11** | **E63/ E11** | **F63/ F11** | **G63/ G11** | |
| 111 | | **Standing cost (rand/km)** | **D63/ D20** | **E63/ E20** | NA | NA | |
| 112 | Other costs | **Variable cost (rand/km)** | **D106/ D20** | **E106/ E20** | NA | NA | |
| 113 | | **Cost per tonne (rand)** | **D108/ (D8* D12)** | **E108/(** | **F108/(F8** | **G108/(G8*G12)** | |
| 114 | | **Cost per tonne-km (100% load)** | **D108/ (D21)** | **E108/ (E23)** | **F108/ (F23)** | **G108/ (G23)** | |
| 115 | | **Cost per tonne-km (75% load)** | **D108/ (D21* 0.75)** | **E108/ (E23* 0.75)** | **F108/ (F23* 0.75)** | **G108/ (G23* 0.75)** | |
| 116 | | **Cost per tonne-km (50% load)** | **D108/ (D21* 0.5)** | **E108/ (E23* 0.5)** | **F108/ (F23* 0.5)** | **G108/ (G23* 0.5)** | |
| 117 | | **Cost per deck metre (100%)** | **D108/ (D12 *D9)** | **E108/ (E12 *E9)** | **F108/ (F12*F9 *(F5+1))** | **G108/ (G12*G9 *G5)** | |
| 118 | | **Total cost per km (rand/km)** | **D108/ D20** | **E108/ E20** | NA | NA | |

**Row 110 (Standing cost (rand/day)):** The total standing cost divided by the number of working days per annum.

**Row 111 (Standing cost (rand/km)):** The total standing cost divided by the km travelled per annum.

**Row 112 (Variable cost (rand/km)):** The total variable cost divided by the km travelled per annum.

**Row 113 (Cost per tonne (rand)):** The total operating cost divided by the total tonnes moved per annum.

**Row 114-116 (Cost per tonne-km (100%-50% load)):** The total operating cost divided by a percentage of the tonne-km.

**Row 117 (Cost per deck metre):** The total operating cost divided by the deck length multiplied by the number of trips made.

**Row 118 (Total cost per km (rand/km)):** The total operating cost divided by the km travelled per annum.

TABLE B.14: *Financial model: Comparison summary continued*

| A | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|
| 3 | | Transport method | DC to DC (super link) | DC to DC (tri-axle) | Catching your own pass | DC to Terminal (2 primary movers) | |
| 119 | | % load | | D119 | D119 | D119 | |
| 120 | | **Cost per tonne-km** | **D108/ (D21* D119)** | **E108/ (E23* E119)** | **F108/ (F23* F119)** | **G108/ (G23* G119)** | |
| 121 | | **percentage of DC to DC method** | NA | **E120/ E120** | **F120/ E120** | **G120/ E120** | |
| 122 | | **percentage of DC to DC method (super-link)** | **D120/ D120** | NA | **F120/ D120** | **G120/ D120** | |
| 123 | | **Cost per trailer per trip** | **D108/ D12** | **E108/ E12** | **(F108/ F12)/ (F5+1)** | **(G108/ G12)/ (G5)** | |
| 124 | | **percentage of DC to DC method** | NA | **E123/ E123** | **F123/ E123** | **G123/ E123** | |
| 125 | | **percentage of DC to DC method (super-link)** | **D123/ D123** | NA | **F123/ D123** | **G123/ D123** | |

**Row 119-120 (Cost per tonne-km):** This is the cost per tonne-km based on a load percentage defined by the user.

**Row 121 (Percentage of DC-to-DC method):** This is the cost per tonne-km of the catching-your-own-pass and DC-to-terminal methods compared to the 6-axle DC-to-DC method.

**Row 122 (Percentage of DC-to-DC method (superlink)):** This is the cost per tonne-km of the catching-your-own-pass and DC-to-terminal methods compared to the 7-axle superlink DC-to-DC method.

**Row 123 (Cost per trailer per trip):** This is the cost of moving one trailer in one trip.

**Row 124 (Percentage of DC-to-DC method):** This is the cost per trailer per trip of the catching-your-own-pass and DC-to-terminal methods compared to the 6-axle DC-to-DC method.

**Row 125 (Percentage of DC-to-DC method (superlink)):** This is the cost per trailer per trip of the catching-your-own-pass and DC-to-terminal methods compared to the 7-axle superlink DC-to-DC method.

## B.6 Decision matrix

When considering the use of different methods of transport, LSPs look at multiple aspects of transport. Some key aspects discussed earlier in this thesis are shown in Table B.15. The weights in the table were acquired from previous research done by Andersen (1995).

TABLE B.15: *Aspects of transport*

| Aspect of transport | Section discussed | Weight of importance |
|---|---|---|
| Reliability | 3.4.6<br>2.9 | 23,6% |
| Speed or punctuality | 3.4.6<br>2.9 | 16,1% |
| Cost of investment and transport rate | 3.4.6<br>2.9 | 15,7% |
| Flexibility | 3.4.6<br>2.9 | 26,0% |
| Safety/security | 3.4.6<br>2.9 | 18,6% |
| Tracking of freight available | 2.9 | No data |
| Frequency of services | 3.4.6 | No data |

These aspects can be used to measure the performance of each transport method. The best way to do this is by using a decision matrix. This decision matrix uses all the necessary aspects of transport to compare the methods of transport mentioned in the financial model in Appendix B.5. This matrix can be used by an LSP to quantify and visualise their attitudes towards these methods. The methods used in the matrix were inspired by research done by Černá, Zitrický, and Daniš (2017) discussed in Section 3.5. Table B.16 shows an example of the decision matrix.

TABLE B.16: *Decision matrix example*

| | | | Transport methods | | | |
|---|---|---|---|---|---|---|
| | | Weight | DC-to-DC superlink | DC-to-DC 6 axel artic | Catching your own pass | DC-to-Terminal |
| Aspects of transport | Reliability | 5 | 1 | 1 | 1 | 1 |
| | Speed or punctuality | 3 | 1 | 1 | 0 | 0 |
| | Frequency of services | 2 | 1 | 1 | 0 | 0 |
| | Cost (Investment) | 1 | 0 | 0 | 1 | 1 |
| | Cost (\tkm) | 4 | 1 | 1 | 0 | 0 |
| | Flexibility | 3 | 0 | 0 | 1 | 1 |
| | Safety/security | 4 | 0 | 0 | 1 | 1 |
| | Tracking (communication) | 3 | 1 | 1 | 1 | 1 |
| | Other factors not yet considered | | | | | |
| | Total | 25 | 5 | 5 | 5 | 5 |
| | Weighted total | | 17 | 17 | 16 | 16 |

Each aspect of transport in the matrix is listed and assigned a weight of importance by the user. The following definitions apply to the aspects of transport:

- **Reliability**: The ability of the LSP to meet contractual agreements;
- **Time/punctuality**: The time that it takes the freight to be transported and the accuracy of estimated times of arrival;
- **Frequency of services**: The frequency of services that are available (Example: one train a day);
- **Cost of investment**: The cost of investing in RailRunner trailers;
- **Cost per tonne-km**: The cost per tonne-km of the transport;
- **Flexibility**: The ability to adapt to the changing of a freight-owners' needs;
- **Safety/security**: Number of accidents, loss of freight, theft etc.;
- **Environment**: GHG emissions, fuel usage, noise pollution etc.;

- **Tracking (communication)**: The ability to track and communicate the location of freight to the freight owner;

The weights of the aspects of transport are defined as follows:

5: Critical

4: Important

3: Somewhat

2: Unimportant

1: Trivial

0: Irrelevant

The four different methods of transport are listed in the top row. Each method of transport can perform better or worse than other methods according to a binary scale of zero to one. Some methods may outperform others depending on what aspect is being looked at. The ones and zeroes represent the following:

1: Performs just as well as other systems with a value of 1;

0: Performs worse than other systems with a value of 1.

When the weights and performance values are inserted in the table, a weighted total can be calculated to be able to gauge the attitude of an LSP toward the use of the different transport methods. The decision matrix can also be used to see what aspects have the greatest influence on the weighted total of certain methods.

## B.7 Frequently asked questions

A selection of frequently asked questions (and answers to those questions) could help to clear up any misconceptions of the RailRunner system or technology.

## B.8 Chapter conclusion

This chapter set up a preliminary toolkit, the elements of which, can be used to construct a structure for exploratory interviews. These interviews will be used to add to and refine the preliminary toolkit until a satisfactory level of completion is reached. At this point the toolkit will be called the finalised toolkit that can be used for validation interviews. This process can be seen in Figure B.9.

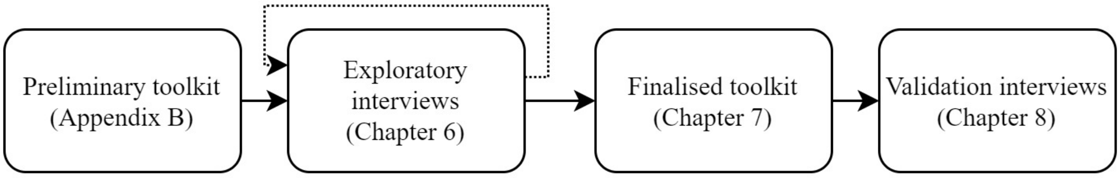


FIGURE B.9: *Toolkit flow of completion*

This chapter forms part of the input to research objective four (finalised toolkit) as seen in Section 1.4.4.